THE TELEGRAPHIC JOURNAL AND

ELECTRICAL REVIEW.

VOL. XXIX. DECEMBER 11, 1891. No. 733

CONTENTS:

	PAGE
Overhead Lines	661
Microphones and the Berliner Patent	662
How Berliner Invented the Microphone	664
Mr. Edison's Electric Railway	664
The Alcock's Electric Lighting Plant at Melbourne	665
The E.M.F. of Metallic Salts	667
Electric Lighting in the City	667
An Important Point in Distribution on the Three-wire System (*illustrated*)	668
Remarks on the Lauffen-Frankfort Experiments	668
Some Curves from Alternating Current Machines (*illustrated*)	669
Notting Hill Electric Company	671
Reviews:—Popular Electric Lighting	672
Condensed Mechanics	672
The *Practical Engineer* Pocket-Book and Diary, 1892	672
The *Mechanical World* Pocket-Book, 1892	672
French Electrical Notes	672
London County Council	673
Legal:—Anglo-American Brush Electric Light Corporation *v.* King, Brown & Co.	673
Proceedings:—Institution of Electrical Engineers	674
Notes	676
Business Notices	681
Traffic Receipts	681
Share List of Electrical Companies	682
The British Association:—Report of Committee on the Phenomena Accompanying the Discharge of Electricity from Points (*illustrated*)	683
Secondary Batteries (*illustrated*)	684
New Patents	686
Abstracts of Published Specifications	686
Correspondence:—Triphased Alternating Currents (*illustrated*)	687
Granulated Iron Cores	687
The Standard Volt and Ampèremeter used at Leven Shipyard, Dumbarton	688
Steam Dynamo Efficiencies	688

J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1892,

IS NOW AT PRESS,

And will be ready in January next. Sent free within the Postal Union for 4s., net. If there be any

ADVERTISERS AND SUBSCRIBERS

who have not yet renewed previous contracts, they should send their repeat orders at once.

CORRECTIONS AND NEW MATTER

can be received up to Saturday, December 19th, but to facilitate getting the work through the press such information ought to be sent earlier to

H. ALABASTER, GATEHOUSE & CO., 22, Paternoster Row, London, E.C.

N.B.—8-page Circular on application.

THE

ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGEKKAY, LONDON." Code A B C. Telephone No. 517

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free, per Year, 19s. 6d. To all *Foreign Countries* (except those mentioned below), per Year, £1 1s. 8d. *Exceptions.*—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia (*viâ* Brindisi), Phillipine Islands, Singapore, Zanzibar, to which the rates are: per Year, £1 3s. 10d.

BINDING.—Subscribers' numbers bound, including case, for 3s. 6d. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

OVERHEAD LINES.

THE action of the Board of Trade in respect to the use of overhead lines for electric lighting has not, as is well known, met with the approval of the general body of electrical engineers and contractors, and various steps have been taken by private firms and by the London Chamber of Commerce to try and induce the Department to relax the stringency of some of its regulations. The result of these efforts, which included the addressing of memorials to the Board, and the making of tests (at the suggestion of the Board's technical adviser) on different samples of cables, with a view to proving how far the contentions advanced were borne out by experiment, has so far been a negative one, it having been found impossible to move the Department from the position adopted by it; and it now appears that the likelihood of any modification of the regulations in the sense desired by the contractors is more remote than ever, as we understand from a circular letter issued by the London Chamber of Commerce that certain contractors have received communications from the Board of Trade, informing them that overhead wires will in no case be allowed as a permanency.

If this prohibition is to be taken in its most general sense, as including every overhead line now in existence, or to be erected in the future, there can be but little doubt that it will seriously interfere with the carrying out of many electrical schemes in suburban and rural districts; but, without further information than is vouchsafed in the letter referred to above, we can hardly bring ourselves to believe that this can be the meaning intended, but rather that the communications addressed to the contractors must refer to lines already erected or planned by them, and of which, therefore, the Board of Trade is in possession of the particulars. Whether this be so or not, the matter has been brought before the Chamber of Commerce, and an address to the President of the Board of Trade has been prepared, copies of which are now being circulated amongst the firms and others interested, with a view to getting the signatures of those who approve of the address.

The address sets forth that, whilst the signatories have no wish at present to question the correctness of the decision arrived at by the Board that overhead wires shall not be used in the metropolis and other large towns, yet they consider that the reasons which may render the prohibition advisable in such cases do not apply with the same force in small towns or in rural districts, where the danger to life and the inconvenience to traffic are far less serious. Attention is drawn to the fact that in small towns and rural districts the probable users of electricity are generally situated at considerable distances apart, and that, therefore, great lengths of conductor are required to reach them, the cost of which, if they must be laid underground, would in many cases be prohibitory, with the result that, unless overhead

wires can be used, such districts will be entirely debarred from all chance of receiving a supply of current for lighting or other purposes.

Reference is then made to the desirability of using overhead conductors for electric traction in rural districts, and it is pointed out that any rule forbidding their use throughout the United Kingdom would seriously retard the development of this branch of electrical work. In conclusion, the address proposes that wherever in small towns or rural districts the undertakers are able to satisfy the Board that underground work would mean prohibitive expense, or would in any way be impracticable, sanction should be given to the erection of overhead wires, subject to such regulations and restrictions as experience may show to be necessary.

So far as believing thoroughly in the *desirability* of placing electric mains underground, we are in agreement with the Board of Trade, and we believe that all engineers who have had practical experience are of the same way of thinking; but there is no doubt that in many cases an overhead line may be erected, which will not cause either danger or inconvenience, for a much smaller sum than the cost of an underground main of the same conductor area; and we consider, therefore, that the Board of Trade should, if they are to be the supreme authority in these matters, appoint a competent staff for the purpose of enquiring into all cases where an overhead line may appear desirable, so that each may be settled on its merits, and the industry may run no risk of being unduly hampered by general regulations which, as a rule, are enforced because the authority which promulgates them has not time to discriminate between one case and another. We do not understand why an overhead line should be considered safe for a year or two—which, apparently, the Board of Trade is prepared to allow—and yet should not be used permanently, when all that is required to keep it in a safe condition is a thorough periodical inspection and renewal of any parts of the structure which show signs of becoming faulty. As regards the question of safety, we may notice, in passing, that there is one statement in the address which might well be explained more fully, and that is that the possibility of danger resulting from the use of overhead lines may be less than would be occasioned by the use of underground mains.

The question of permanent use is indeed the most important of all, as if an expensive overhead line such as that required by the present regulations, is only to be used for a couple of years or so, and is then to be replaced by underground cables, it will always be cheaper to lay the latter at once, and contractors must then content themselves with work in districts sufficiently populous to allow of the use of underground mains, and must leave the wants of the rural districts to be ministered to by a future generation, who may perhaps have discovered new methods of transmitting electrical energy without the clumsy and expensive conductors which we of the present day are obliged to use.

As the matter, however, is one of the present time, we have no hesitation in urging that the memorial should be signed by the whole of the electrical profession, for it merits their hearty support and approval.

At the same time we would point out that the main difference likely to arise between contractors and the Board of Trade is in the method of erecting overhead wires. For if we read the Act rightly the Board of Trade have no power to prohibit overhead lines—providing the consent of the local authority is obtained—but they have power to prescribe such onerous and unnecessary conditions that overhead wires become impossible.

MICROPHONES AND THE BERLINER PATENT.

ON October 29th last the Commissioner of the U.S. Patent Office directed the allowance of a patent to Emile Berliner for a "Combined Telegraph and Telephone," the application for which was filed on the 4th of June, 1877. The long period which has elapsed between the application and the issue; the fact that the patent is supposed to cover the essential feature of telephonic transmitters, and may possibly prolong for another decade or so a monopoly which most people—except, perhaps, the owners of the patent—were in hopes was within a few years of ceasing; have combined to draw considerable attention to the subject. Amidst much exciting comment outside them, we are glad to note that our American electrical contemporaries are able to take a calm survey of the situation.

There are happily no "interferences" to interfere with telephonic progress here, and we can altogether disregard the commercial questions involved. But there are considerations of much practical and scientific interest, to which we may briefly refer.

Since May 8th, 1878, when Prof. Hughes's paper was read before the Royal Society, we have become accustomed to regard the microphone as representing generically the various subsidiary types of telephonic transmitters. The principle upon which the microphone acts was explained by Prof. Hughes to be due to a difference of pressure at the different points of contact. Berliner's patent, deposited eleven months earlier, commences with the statement, "It is a fact that if at a point of contact between two conductors forming part of an electric circuit and carrying an electric current the pressure between both sides of the contact becomes weakened, the current passing becomes less intense."

The manner in which Prof. Hughes arrived at his discovery is fully explained in his paper. Mr. Berliner has explained that his discovery was due to ascertaining the variations which occur with Morse instruments, according to the firm or loose contact of the key. Prof. Hughes was helped to his discovery by the utilisation of a Bell telephone for the purpose of detecting changes in a current hitherto undetectable, but Berliner used exactly similar instruments depending on contact changes for both transmitting and receiving. Prof. Hughes apparently regarded the variation of resistance between contacts as not being well known, whilst Berliner states it as "a fact," as if it were a well known fact. On this point we think importance is to be attached to the publications referred to by Mr. A. M. Tanner in an article on "The Evolution of the Microphone," which we published on November 21st, 1890, wherein the similarity between previous researches and Berliner's apparatus was referred to. But Berliner in his patent has claimed the utilisation of "the fact" of varied resistance by varying pressure between electrodes when that variation is

produced by sound waves, so as to cause electrical undulations similar to those sound waves.

We think it is somewhat remarkable that the microphonic element of Prof. Hughes's paper has monopolised attention to the disregarding of its other important feature. The microphone, though an important detail, was not the main subject. Starting out with the intention of elucidating the variations of resistance due to the stress of conductors, Prof. Hughes was led to his microphonic discoveries by the rupture of the conductor, and concluded by exhibiting a transmitter which he gave reasons for believing could not be dependent for its results upon the variations of contacts, but must be due to molecular action in the mass produced by sonorous vibrations, the exposition of which was the chief purpose of the paper, as is exemplified in its title: "On the action of sonorous vibrations in varying the force of an electric current."

Since 1878 many forms of telephonic transmitters have been made, but all those which have been put into practical use are called microphones, and their action is attributed to the microphonic principle of variation of current by contact pressure. The microphone was devised by Prof. Hughes for magnifying weak sounds; and for the purposes of a telephonic transmitter other apparatus was devised, dependent for its action on variation in its mass, due to sonorous vibrations.

It seems to us there may be some practical and scientific interest in enquiring how it is that the application of Prof. Hughes's discoveries has been limited to, or attributed to, the contact principle, and that the molecular principle has been apparently lost to sight. We have little doubt that Prof. Hughes would find the present time to be opportune for further researches in the same line, and upon the results of some such researches much of the scientific importance of the Berliner patent will depend.

Telegraphic Abbreviations.

A SYSTEM of code or abbreviated messages was decided upon by the London and North Western railway telegraph department in 1884. The result generally has been eminently satisfactory, and now after seven years' working experience, the system is so favourably looked upon that the list of codes has been considerably enlarged, over 700 sentences and phrases being added to the original list. In 1889 (with the old list in use), when some particulars were taken, it was found that at *one* station alone, the adoption of the code saved the signalling of over 5,000 words in *one day*, which taking the extensive railway system into account, means a considerable item saved in the way of wires and clerks. The principle upon which the list is framed will perhaps be better understood from a reference to the list classified for received messages. The letters, A to M, commonly used for signalling time are discarded, and the code starts with N and goes to Z, then NA to ZA, NB to ZB, &c., to ZZ; and with three letter codes, NAA to ZAA, NBA to ZBA, NCA to ZCA, &c., &c. Some objections were at first raised on the ground of liability to error owing to the codes being formed of meaningless letters, and not in the form of a complete word which the telegraph clerk could comprehend, but this was soon found to be groundless, and it is stated that there are no more errors than with messages written out in full in the ordinary way. In 1889 when an examination was made, it was found that fully 75 per cent. of the messages sent over the wires were abbreviated. Several of the large railway companies have adopted the system.

A New Word.

SOME of our American contemporaries appear to be making a determined effort to introduce a new word into electrical technology, namely, the word "dynamotor" which somebody or other has hit upon. The word "motor" alone, they say, is not specific enough, "for we have motors of all kinds, properly so-called, for utilising the force of water, air and steam. *Electric motor* seems long, and must consist of two words, but "*dynamotor*" is short, euphonious and relevant." We must say that we think this new word no great improvement upon our own term, and we think the philologists will be inclined to quarrel with a word, which taken literally with regard to its derivation (a mixed one, by the way), can mean nothing more than "force-mover." If the American electricians are content with a word of no more specific significance than this, they are welcome to the sole use of it as far as we are concerned. The electrical fraternity may take some legitimate pride in the fact that hitherto they have, above all other craftsmen, avoided slang, in a nomenclature perhaps wider than any other science or art has ever called for in so short a time. Names instead of coming by accident and from ignorant sources, have been agreed upon by learned people, and often in international congresses. Consequently they are systematic, and do not, as names commonly do, possess several meanings. Until our American *confrères* can show us good reasons for accepting their new word, we must decline it with thanks.

Turbines or Wheels?

AT one of the recent meetings of the National Electric Light Association, in Montreal, Canada, a highly interesting and practical paper was given by Mr. George A. Redman on the subject of water power for central stations, in which he illustrated his arguments by reference to the plant that is being worked at Rochester, U.S.A. At this installation, pressure turbine wheels, working under a head of 90 feet, are used for obtaining the necessary power. Several of the well-known disadvantages pertaining to enclosed or pressure turbines, under high heads, were dealt with exhaustively in this paper, and attention was especially called to the "burning of foot-steps," which is a pronounced peculiarity of these motors working under this condition. It is, perhaps, still an open question whether enclosed turbines should be employed at all for this purpose, and there are eminent authorities who consider open wheels to be preferable, not only on account of their possessing fewer structural faults, but also on account of their comparatively low cost. In New York, a determined effort is being made to solve this question by the manufacturers of the "Pelton" wheels.

Specific Resistance of Copper.

THE subject of the specific resistance of copper has lately come before the American Institution of Electrical Engineers, who agreed to adopt Matthiessen's results as the standard to be accepted, recommending that the Matthiessen standard should be the metre-millimetre of resistance ·02057 B.A. Mr. Holman in a recent communication falls foul of them, and with good reason argues that the metre-gramme is a far preferable unit, both for practical utility and for ease and certainty in getting accurately. He also points out that the formula given by the committee of the institution for the variation resistance with temperatures is wrong; the formulæ given by Mr. Holman seem to tally with Matthiessen's results, and may well be quoted. They are:—

(1) From 0° to 100° C., $R_t = R_0 (1 + \cdot004019\, t + \cdot00000214\, t^2)$.

(2) From 0° to 30° C., $R_t = R_0 (1 + 003879\, t + \cdot00000526\, t^2)$.

These represent the actual results as near as the experimental errors themselves, and should prove useful.

HOW BERLINER INVENTED THE MICROPHONE.*

IN view of the decision of the U.S. Patent Office, awarding Mr. Emile Berliner a patent on the microphone, as noted in our special bulletin last week, the following account of the manner in which he made his discovery and invention will be of great interest. It is taken from the biographical notes prepared by him at the request of the editors of *The Electrical Engineer*, and upon which an illustrated biographical sketch was based, appearing November 19th, 1890 :—

"As soon as I had returned to Washington, in 1876, I began electrical experiments, and for the purpose of learning something, paid visits to the Fire Alarm Office, where the operators were kind and ready to answer all questions.

"I had just commenced making diaphragms and contacts, and had looked up Bell's patent of 1876, when one day Mr. Richards, one of the operators, at my request, showed me how to manipulate a telegraph key. 'You have to press down harder, otherwise it may happen that the sounder at the other end will not respond well.'

"I immediately asked him for a thorough explanation of this, because it had flashed through my mind that if pressure made a difference in an electrical contact, and modified the current passing the contact, then a vibratory contact would transmit speech by means of undulatory currents. In this manner the telephone transmitter, afterwards known as the microphone, was invented.

"I at once set to work to study this principle and tried to transmit speech, using for a receiver an apparatus as shown in Bell's patent of 1876. For a transmitter I used metallic diaphragms touching screws tipped either with platinum, steel, or broken lead pencil points. One day, in April, 1877, I had adjusted the transmitter—a soap box and a black sheet-iron diaphragm against a steel ball—to the utmost nicety, *i.e.*, an extremely loose contact, and closing the two wire ends leading to the battery, I suddenly heard a scraping sound coming from the transmitter. I had discovered that a microphonic contact could be vibrated by a current, and that such a transmitter would act as a receiver of sound as well.

"This analogy with the Bell telephone," he says, "struck me very forcibly, and immediately making a duplicate transmitter, two days afterwards I actually transmitted speech and music with these two simple contrivances, almost as simple as a lover's telegraph. This work was mostly done before, or after business hours, or on Sundays. I now tried all sizes of instruments, and various metals as diaphragms, and finding that distance would weaken the effect very considerably, hit upon the idea of placing the transmitter in the primary of an induction coil, thereby transforming the undulations into high-tension currents, passing these over the line wire, and re-transforming them again into low-tension currents at the other end to actuate the microphone receiver. No Bell telephones were used in these tests, but each instrument was used both for transmitter and receiver. My patent for this was issued January 15th, 1878, and was later reissued. Without this, practical telephone work would be impossible. When, soon afterwards, I was introduced by a prominent Washingtonian, Mr. A. S. Solomons, to Prof. Henry, this great scientist was particularly pleased with the use to which I put the induction coil. I mentioned to him at the time that telephone circuits were found to be affected by parallel wires on which Morse signals were sent. He then related to me that he himself had traced signals on long lines between two wires which were a mile apart.

"I made some attempts to interest practical electrical men in the transmitter principle, and in January, 1878, visited the New York local branch of the Bell Telephone Company, but they refused to pay a very modest sum for the invention, which was then not yet perfected. It was not until during the summer of the same year that, by request of Mr. Anthony Pollok, the attorney of the Bell Company, Mr. Thos. A. Watson, general superintendent of the Bell Company, visited Washington and examined the transmitter, when he immediately declared that his company would want it. As one of my conditions, I asked to become a member of their electrical staff, and a contract was closed in September, 1878, in New York. Returning to Washington, a few nights later, to prepare for leaving, I sank into a severe nervous prostration, which lasted seven weeks, and from the effects of which I suffered many years afterwards. Leaving the hospital, I went to New York to enter upon my new duties."

* New York *Electrical Engineer*.

MR. EDISON'S ELECTRIC RAILWAY.

BY A. RECKENZAUN.

ABOUT a month ago Mr. Thomas A. Edison was interviewed by a reporter of the *New York Herald* on the subject of a plan for the development of electric railways. Anything that comes from Mr. Edison receives public attention. The daily press took the matter up as a wonderful discovery. Telegrams and cablegrams were sent to all parts of the globe announcing the important fact, and the powerful president of the Edison General Electric Company, Mr. Henry Villard, was reported to back the new scheme to any extent, even to the working of big railroads electrically. Little or no notice would have been taken by the press or the public had anyone else made suggestions similar to those imputed to Mr. Edison in the *New York Herald* of October 25th, 1891. Experts, and even amateurs, would have smiled at the idea, which, in principle, is as old as the oldest electric motor. No sooner was the electric motor invented, and we may go back 50 years and more for that, than the suggestion was made to use the rails upon which electric cars were to be run as the medium for conveying the energy to the propelling apparatus. Messrs. Siemens and Halske, of Berlin, worked a practical line on this plan 12 years ago, and Mr. Volk's little railway at Brighton is still in operation as an example of what can be done with electricity in moving cars with the current supplied through the rails. In these and other similar cases tensions of over 100 volts are employed, and though the rails are fairly well insulated from each other by creosoted wood sleepers, the leakage in wet weather is considerable. Any traffic across the tracks is carefully avoided, and no one with sufficient experience has hitherto had the courage of publicly announcing that electric currents may safely be sent through both rails of a tramway in populated highways with the object of propelling electric cars along streets where every other kind of traffic is carried on, such rails being exposed, and continuously in electric contact with the source of supply. Mr. Edison is satisfied that the thing can be done economically; he has experimented, has obtained certain data, and he is going to equip a line in the vicinity of New York City at an early date. Twenty volts is the maximum tension to be used, and with this low voltage neither beast nor man can be injured, or even feel the presence of the electric current. The first questions which an electrician will ask are: How is Mr. Edison going to prevent leakage to earth and across the rails having a difference of potential of 20 volts, especially in wet weather? How is he going to prevent metallic parts of other vehicles taking the current, or even short-circuiting the whole arrangement? The tramway engineer at once enquires, How are the rails to be tied? Any materials other than stiff metals cannot be relied upon to hold the rails permanently in position. To all these questions Mr. Edison will give answers as soon as detail patents are obtained in every country. Some he has already answered in the presence of a representative of the New York *Electrical Engineer*. Anyone might assume that carriages with iron wheels passing over the tracks would short-circuit the line and cause the destruction of the dynamo machines, as well as damage the short-circuited vehicle. To test this, Mr. Edison is said to have actually "short-circuited his experimental track with a carriage having iron wheels, and succeeded in getting only 200 ampères through the wheels, the low voltage used, as well as the insulating properties of the axle-grease, being sufficient to account for the small quantity of current which actually passed through." Another experiment was made by "short-circuiting the track with an iron bar. As a result, it was found that with the iron bar polished, and contact effected by a man standing upon the bar, only 1,000 ampères passed through it; that is, the amount which would be taken by a single car, and hence far below the capacity of the

generators." Nothing is said about the shape or dimensions of the bar. Probably a flat bar was placed upon rails with curved tops, which would give a small contact area; but the wonder is that in this case the bar was not welded to the rails, taking it for granted that the generator was capable of giving a larger current than 1,000 ampères. I can only explain the limited flow of current in these cases to the small contact between the bar and rails, due to curvatures. Doubtful as these results seem to be, the experiments of Mr. Edison on the leakage between rails are decidedly interesting, and, apparently, more conclusive. He is said to have proved that "at a potential difference of 20 volts the loss of current due to leakage between the rails under the worst conditions, with a wet and salted track, is only 5 H.P. per mile, while very wet weather would involve a loss of only 2·5 H.P. per mile." A heavy rain will reduce the leakage between the rails by washing away the accumulations between the tracks, due to the droppings of horses, which serve largely to increase the conductivity of mud. In dry weather the loss is necessarily smaller. Taking it for granted that the rails are partially insulated from earth, and that the maximum loss is 200 ampères per mile, due to the worst dampness in the road, and that we have four cars to the mile, this leakage would amount to about 50 ampères per car. The average power used by a full sized loaded tramcar on an ordinary road should not exceed 10 electrical H.P., but a maximum of 30 H.P. must be provided for at the generating station. The average current per car will therefore amount to 373 ampères. The loss under the worst conditions of roadway, with an interval of barely two minutes between the succeeding cars, would therefore be $\frac{50 \times 100}{373} = 13{\cdot}4$ per cent., which does not seem excessive. What the loss will be through wheel tires and brake gear of other vehicles, setting aside iron wheels and short circuiting bars, cannot well be ascertained; but one feels inclined to think that at odd times it may be enormous.

It is not stated how Mr. Edison is going to send the current from the generating station to the cars. The rails themselves, even if made heavy, say 100 lbs. to the yard, giving a section of about 10 square inches, should not carry more current than sufficient for two cars; therefore he must have either copper feeders of very large section, or motor generators stationed at intervals along the line. As regards first cost, there will be little to choose between heavy copper rods on the one hand, or a large number of motor generators on the other; for, in any case, the system, assuming it practicable, can only be applied to roads with a very large traffic, otherwise the necessary losses per mile would form too great a percentage on the power used for propulsion. Mr. Edison estimates the cost between £6,000 and £20,000 per mile of double track, not including the cost of stations, and depending between these limits upon the amount of traffic. The running expenses he estimates will be exactly the same as with the overhead wire system. These figures are considered to compare favourably with cable roads, which, without stations, are said to involve an expenditure of between £30,000 and £60,000 per mile.

It is quite out of the question that Mr. Edison can use existing tracks without pulling them up, for the purpose of removing the metal tie rods and replacing them by insulated ones; the road must also be disturbed for the important purpose of thoroughly connecting the rails with the feeders.

If this system should come into use for tramways, and I see no advantage in low-tension working for big railways, it will possibly evolve a new thief or electro-kleptomaniac. The temptation will be there on account of the ease with which one could draw energy from the rails, to be stored up if desirable in secondary batteries, carried by a trap going over the charged rails, picking up current all the while.

All sorts of possibilities come into one's mind; one is that the rails themselves and connections with other metals will form a kind of semi-dry storage battery, consisting of electrodes of large surface. What will become of one or the other of these electrodes after a while, with unlimited local action, is difficult to realise.

The advantage which Mr. Edison's system has, or might have, is the absence of overhead conductors.

An incidental advantage to this system, apart from having no overhead lines, would come out at night and foggy days. The cry is "More light." By Mr. Edison's method we see this provided. The vehicular traffic would not be the quiet prosy thing of the present, but would be one brilliant scintillation of flashes and sparks, to say nothing about the occasional welding of an entire coal waggon, for example. The current coming up the wheels into the loaded waggon, setting up numerous arcs between oscillating carbons, would be a grand sight, and put pyrotechnics of the past into the shade.

THE ALCOCK'S ELECTRIC LIGHTING PLANT AT MELBOURNE.

THE opening of the new electricity works of the A. U. Alcock Electric Light and Motive Power Company, Limited, of Melbourne, took place on October 23rd. These works are destined to supply the lighting contracts of the company for Melbourne, Richmond, Collingwood, Hawthory and South Melbourne. There were a large number of gentlemen, including members of Parliament and other public men, to witness the ceremony of starting the machinery, which was performed by Sir James MacBain.

The chairman of the company, Mr. W. J. Mountain, M.L.A., after the usual loyal toasts, proceeded to explain the business for which those present had been brought together. Some three or four years ago Mr. A. U. Alcock started a small electrical plant of his own for the supply of a few lights just around his father's billiard factory. It was so successful that more machinery was required, and seeing the gigantic proportions that it was likely to attain, the business was floated into a company in September, 1889. In November of the same year a temporary station was started in South Melbourne, and afterwards the company purchased a suitable block of land for the erection of a central station easily accessible to the metropolis and surrounding cities.

The station just opened is not only destined for lighting purposes, but the company is in a position to supply also motive power to the consumers. The chairman of the company said he felt confident that before another year was over the present section of the central station would be full of machinery and fully employed, and that the second section would be under construction.

The following is a short description of this interesting station:—

The first section of the building, which is now completed, stands on the site of the quarry hole in Burnley Street, Richmond, having a frontage of 373 feet by a depth of 246 feet, and known by the name of the Wine Cellars. This will now be of the greatest commercial value to the company, owing to the quantity of water obtainable from it.

The building, when completed, will have a frontage to Burnley and Neptune Streets of 192 feet 6 inches, by a depth of 246 feet 6 inches.

The boiler room is situated on the basement floor, which is 18 feet below the pathway levels, and will extend the entire length and breadth of the building. It is divided into three sections, each accommodating 22 boilers, connected by flues running the length of each section, with four chimney stacks, each 155 feet high by 16 feet wide at the base, which diminish externally, but have the same diameter inside throughout the full length of the shafts. The present one is most substantial, and the first of the kind erected in the colony.

The walls of the engine room are 22 feet from the floor to foot of iron principals, and 42 feet to lights in roof, and divided into three sections, each 246 feet long, by a span of 66 feet. The floor is 5 feet 6 inches above the street level (thus allowing the boiler room a plentiful supply of air), and supported upon heavy iron girders, filled in between with cement concrete, upon 16-gauge Traegerwellback iron, thus making the floor entirely fireproof. The basement is lighted by prismatic lights 3 feet 6 inches wide, formed in the engine room floors, running the length of each section. It is also lighted by incandescent lamps suspended from each arch. Tram rails have also been put down for the purpose of moving heavy machinery to any part of the building.

The roof is formed of heavy iron trussed principals, with a span of 66 feet, carrying louvre ventilators and skylights the length of the building, alternating arc lamps being used for lighting during the night. The switchboard at the end of the engine room is 32 feet long and 18 feet high, made of black polished marble slabs 1½ inches thick, in a handsome cedar frame with turned and carved columns, caps resting upon moulded pedestals, and supporting a massive entablature with dental cornice and enriched pediment, and is to form a part of the main switchboard in the distributing tower when completed.

The whole has been designed and carried out by Mr. Harry B. Gibbs, F.R.I.V.A., architect to the company, the contractor being Mr. F. M. Bale.

The boilers, three in number (but room has been provided for 10 in the present section), are marine multitubular steel boilers, fitted with furnaces 13 feet long, 3 feet 4 inches in diameter, with Fox's corrugated pattern furnaces. The combustion chambers, which are connected to the furnaces, are constructed with an arched top, so as to secure, as far as possible, the greatest amount of heating surface with the ratio of strength. The boilers are set on wrought iron cradles, saving brickwork, and making them easy of access in case of repairs; they were manufactured by Langlands Foundry Company to order, and are of the same type as supplied to the tramway company, who have adopted this pattern as the best colonial made boilers for the generation of steam and economy of fuel. Each boiler has a feed pump by the well-known makers, George F. Blake & Co., double-acting under any pressure of steam, and can be regulated to supply the exact amount of water required. The pumps have been connected with the mains or with the large reservoir by a suction pipe, so that a constant supply is guaranteed; also in case of accident they can be made to supply any boiler, and as a still further guarantee against failure of water to the boilers, each have a Korting injector. The action of this injector is positive, and the simplicity of its working entirely by one lever, so that with its reliability and the pumps the feed for the boilers is perfect, which is a matter of the utmost importance where a large steam power is necessary.

The engines were made by Wright and Edwards, Limited, and are 16-inch cylinder with a 27-inch stroke, high-pressure, coupled, running at a speed of 100 revolutions per minute, with a 12 feet nine grooved wheel, controlled by governors of the Porter pattern, which are driven by mitre gear to obviate the possibility of any variation in the speed, which might occur with a belt if it slipped, which would necessarily cause a fluctuation in the lights. The Llewellyn heaters, which utilise the exhaust steam for heating the feed-water for boilers, are connected with the boiler pumps, and were made and fitted by the same firm. A Hornsby high-speed vertical engine, running at a speed of 400 revolutions per minute, is used to drive the arc machine.

The electrical machinery is by Ganz & Co., Budapest, consisting of four alternators and two exciters—A6-type, running in parallel—and each capable of an output of 80,000 watts, at 2,000 volts by 40 ampères or 2,000 ten candle-power incandescent lamps. The alternators, which are coupled direct to the engines by rope gear, are of the latest type, having 14 laminated field magnet cores, which revolve 360 times per minute, making 42 periods per second. The exciters are driven from two alternators by patent link belting of the latest manufacture. A Woodhouse and Rawson's tachometer is attached to each alternator, which gives a constant reading of the exact speed of each machine, and enables the instant detection of any slip in the ropes or variation of the speed, which is of the utmost importance.

The Wood's American arc dynamos, five in number (but only one fitted at present), are capable of supplying 220 2,000 candle-power arc lamps. These are fitted with automatic regulators, which regulate the supply of energy required according to the number of lamps in use. These machines hardly require much description, as the brilliancy and steadiness of the lamps supplied by the company from the City and South Melbourne stations since the starting of the company are too well known.

The arrangement of the switchboard was designed by Mr. A. U. Alcock to manipulate the current generated by engines up to 2,000 H.P., which the present section of the building is designed to hold. The work, with the exception of the instruments, has been manufactured under his immediate superintendence. It is arranged into three sections, the centre containing all the switches, ampéremeters, voltmeters, regulators, phase-indicators, &c., by which the current supplied by each of the alternators is regulated. On either wing are arranged switches, regulators, and measuring instruments, which control the supply to the various feeding centres, three of which are at present connected with Melbourne, Richmond and Collingwood. Under the parallel system each alternator supplies its power into one pair of main wires common to all, running the length of the board, and from which each district draws its supply; but as they all differ in distance from the station, and the quantity consumed naturally varies, for this purpose a specially devised compensator and indicator has been designed to secure an equal pressure being maintained throughout the system. A most important innovation is the introduction into each of the feeder circuits of a Blathy meter, which will record the total current supplied to each individual district during the month, so that any leakage or faulty registration of consumers' meters may at once be rectified. A recorder for tracing on a diagram the total output of the station during each hour of the twenty-four is also used. Sir William Thomson's electrostatic voltmeters and ampère gauges are used on the high-tension circuit, also one of his multicellular electrostatic voltmeters with inspectional scale on the secondary circuit, the great value of these instruments being their economy in not absorbing any current, and being free from temperature errors.

There are two novelties introduced which are the invention of Mr. A. U. Alcock, called an automatic electrostatic switch and electrostatic balance. The former is used for the purpose of throwing each alternator into the main current as required. The usefulness of this instrument is obvious, on account of its hitherto having had to be left to the quickness of the eye and hand, also judgment of the operator, which is a great risk, and if done carelessly great damage might ensue. The electrostatic balance is used to detect any leakage on the mains that may occur at any time, being a constant indicator of the state of the insulation. The switches have been especially constructed and modelled on an English pattern, but with requisite improvements on the originals, which make them much safer and more reliable—in fact, absolutely safe from fire or danger to the operator. To the left of the switchboard is a lamp battery, which consists of 1,000 16-candle-power 100-volt incandescent lamps in 50 groups of 20 in series, which are thrown in and out of circuit by a special 20-part contact switch. This is used for the purpose of preventing any fluctuation in the lights while the machine is being thrown on to the mains, the machine then being gradually released of its artificial load.

The conductors connecting the alternators and exciters to the switchboard are highly insulated cables, supplied by the Silvertown Cable Company, and secured by porcelain insulators, each conductor being protected by a double pole fuse, which will prevent any excessive flow of current occurring on any particular machine or main; without this precaution it might be a source of danger.

The whole of the boilers, engines and electrical machinery, have been erected under the designs and personal supervision of Mr. A. U. Alcock, assisted by Mr. W. Phillip's, the company's engineer in charge, and the electric machinery, with the alternating current transformers and meters, have been supplied by Mr. Charles Flesh, as the sole agent of Messrs. Ganz and Co., of Budapest.

The City and Guilds of London Institute.—The annual report of this Institute for 1891, which has recently been issued, states that the total number of worked papers was 7,416, as against 6,781 in 1890; the number of passes has been 4,099, as against 3,507 in 1890, showing an increase in the percentage of 3·5. Examinations were held in 53 subjects, the number in the previous year being 49. In "Electrical Engineering," there is a large increase in the number of candidates, and also in the number of those who have succeeded in passing. In "Telegraphy" the number of candidates has risen from 117 to 206; and although the percentage of failures has likewise increased from 42·7 to 63·5, 75 have passed this year as compared with 67 in 1890. In "Electric Lighting," 392 candidates presented themselves this year as against 256 in 1890, and the number of successful candidates has increased from 173 to 262.

THE ELECTROMOTIVE FORCE OF METALLIC SALTS.

IRON.

CONTINUING our notice of Mr. C. L. Speyers's researches upon the electromotive force of metallic salts, we next come to those of iron. Here an amalgam with iron was not readily obtainable, so the metal in the form of pianoforte wire was arranged in a cork, and the measurements performed exactly as with copper. A long table of these measurements is given in the original article (*vide American Chemical Journal*, Vol. xiii., pp. 475—477).

The following general conclusions were arrived at, having in mind the uncertainty due to tarnishing—an uncertainty much less in most cases than with copper, both in percentage and in absolute value.

1. The electromotive force always increases on dilution, except in solutions of the pure ferrous and zinc salts. Solutions containing ferrous acetate behave very curiously, for the electromotive force rises nominally to the tenth dilution, when a drop of from 140 to 240 milli-volts occurs. The result of the drop is to make the increment sometimes negative.

2. The electromotive force in hydrochloric acid is lower than in the other three acids, which again form a group by themselves, with nitric acid the lowest.

3. The electromotive force in equivalent mixtures containing hydrocholoric acid equals or is less, never markedly greater, than that in hydrochloric acid alone. The other acids have an electromotive force so nearly equal, that an equivalent statement cannot be demonstrated in their mixtures; yet it appears that the influence of that acid predominates in which the electromotive force is lowest.

FERRIC SALTS.

4. Substitution of iron for hydrogen apparently raises the electromotive force, but the excessive secondary action, tarnishing of iron or mercury, or decomposition of liquid, makes numerical comparison illusory.

5. In mixed solutions of two salts of different metallic and acid radicles, the electromotive force shows no regular dependence upon the constituents.

6. The electromotive force in $\frac{1}{3}$ Fe R_3 + $\frac{1}{1}$ H R′ is not always equal to that in $\frac{1}{3}$ Fe R'_3 + $\frac{1}{1}$ H R, especially in $\frac{1}{3}$ Fe $(NO_3)_3$ + $\frac{1}{1}$ H Ac and $\frac{1}{3}$ Fe Ac_3 + $\frac{1}{1}$ HNO_3. However, the colours of the two mixtures showed that their constituents were not the same, but after heating for a couple of days to about 100°, they were indistinguishable in colour and electromotive force. Similarly, with $\frac{1}{3}$ Fe_2 $(SO_4)_3$ + $\frac{1}{1}$ H Ac and $\frac{1}{3}$ Fe Ac_3 + $\frac{1}{2}$ H_2 SO_4.

FERROUS SALTS.

7. The introduction of iron increases the electromotive force in three cases, but in the fourth diminishes it. However, in the latter the increment is strongly positive, while more or less negative in the other three, indicating a difference in the action of ferrous acetate, on the one hand, and ferrous chloride, nitrate, and sulphate, on the other. Moreover, the low electromotive force in the acetate is raised by the addition of acetic acid, so that when compared with the other ferrous salts correspondingly treated, the acetate assumes its proper position, and the chloride has the smallest value.

8. The electromotive force is lowest in solutions containing chlorine, excepting the ferrous acetate solution.

9. The electromotive force of $\frac{1}{2}$ Fe R + HR′ is equal to $\frac{1}{2}$ Fe R′ + HR, where R is chlorine; otherwise the agreement is unsatisfactory, as in solutions of ferric salts.

TIN.

An amalgam was used in most of these measurements. Tarnishing occurred only in nitric acid and in solutions of ferric sulphate and nitrate; but so violently in the last, that no value could be attached to the measurements in it. A tin rod was substituted for the amalgam in some of the experiments.

The following conclusions are based upon a consideration of the tables given on pp. 479, 480 of the *Ann. Chem. Journal*.

1. The electromotive force rises in general on dilution; in nitric and sulphuric acids, however, the increment is markedly negative. In the first case the amalgam tarnished when left in the liquid for some time, to avoid which the values had to be recorded, while still increasing, though very slowly, and in the second case the same was done to avoid tarnishing. In acetic acid the negative increment is very slight; both it and the somewhat larger numerical values in the iron solutions can be explained by a secondary action which was found to exist in the solution of ferric acetate. A very curious observation was made in solutions of stannous chloride, alone and with acids, a proceeding the reverse of that in ferrous acetate, for the electromotive force decreases to the 5th—9th dilution when a sudden rise occurs. This is possibly due to the formation of stannic salts; yet the solution of stannous chloride and nitric acid gave a precipitate with mercuric chloride at the 9th dilution.

2. The electromotive force in hydrochloric acid is much lower than in the other acids, which latter form a group by themselves.

3. In mixtures of hydrochloric acid with other acids the electromotive force is the same as that in hydrochloric acid.

4. Substitution of stannic tin for hydrogen hardly changes the electromotive force, but substitution of stannous tin lowers it very much.

5. In mixtures of salts containing different metallic and acid radicles the electromotive force is determined by the constituent having the lower value.

In our next notice of this paper we shall conclude with some deductions upon the foregoing taken collectively, and follow Mr. Speyers in his considerations of the supposed law that the electromotive force is increased by dilution, and see whether it can be explained by the dissociation or "ionisation" hypothesis.

ELECTRIC LIGHTING IN THE CITY.

IT will doubtless have been noticed by our readers that a large number of contemporaries have recently been, and are at present, criticising the position of the contract for the carrying out of the electric lighting of the City, and also the action taken up by the City Commissioners of Sewers in refusing to grant the extension of time prayed for by the City of London Electric Lighting Company. We have already referred to the remarks made by the *City Press*, and we now briefly glance at what *Money* has to say on the matter. Our contemporary thinks that the decision of the Commissioners is just what might have been expected, and that it is satisfactory to find the majority of the Commissioners firm in their determination to refuse any concession to the electric lighting company, which must be held definitely to the terms of its contract. "Indeed," says our contemporary, "the more the facts are considered the less grounds do there appear why such a request should have been made." It is all very well for our contemporary to argue in this way, but they have evidently only looked at one side of the matter. When it is considered that there is apparently no *definite* penalty attached to the contract, and that if the contracts were cancelled (as one of the speakers at the meeting proposed) with the company, and placed in other hands, there would be an enormous unnecessary expense, and the matter would be in a still more indefinite position than it is at the present moment; we think, under such circumstances, that by far the wisest plan would have been for the Commissioners to have granted the extension. But, to refer again to our contemporaries, we notice that *Money* believes the plain truth to be that the present company has nothing like sufficient capital to complete the work undertaken; and, it sees no prospect of obtaining it on anything like reasonable terms for some time to come. There has already been far too much money squandered and frittered away in the promotion of the present company and its predecessors.

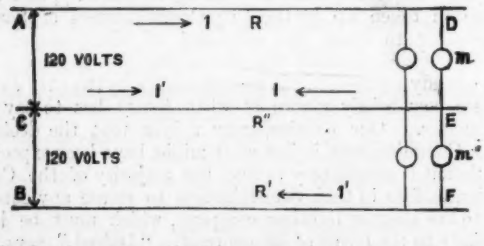
Leaving our financial critic, we would draw attention to the remarks of *The Gas World*. This journal says

that "the arguments by which the company sought to support its application for an extension of time are certainly peculiar, in face of the fact that we have been repeatedly told that the electricians only wanted the opportunity to show us what can be done in the way of public lighting by electricity. Now we are gravely informed that after half the period given for the completion of the contract had expired, 'nearly everything remained to be considered and done,' and that pending the results of investigations by the 'best advice,' the company had already expended large sums in preparations. In our credulity, we imagined all this had been done a couple of years ago, but now we learn with a shock of surprise that all the original contractors, the Pioneer Company and the City Company, have been able to do has been 'to consider.' The Pioneer Company 'considered' to some purpose, for it returned its capital to the shareholders plus a 50 per cent. bonus. Now that the City Company has been distinctly told that the Commissioners have had enough of 'consideration,' the future developments of the affair will be worth watching."

We quite agree with our contemporary's closing remarks as to the future developments, and, while we think that certain blame attaches to the company, and that the contractors would have their just reward if the contract were annulled, yet we firmly believe that under the existing circumstances it would be in the general interests of all concerned if the Commissioners would reconsider their decision, which was only carried by a majority of 6; there being 34 members who voted for the refusal of the application, and 28 in favour of it.

AN IMPORTANT POINT IN DISTRIBUTION ON THE THREE-WIRE SYSTEM.

THE three-wire system of distribution, says *Electrical Plant*, has been often praised excessively, but certain disadvantages have not been sufficiently noticed. Our contemporary has had occasion to notice several of these in a central station. The most important of them all is that which occurs when equilibrium between the output of the two circuits is not maintained. In this station equilibrium had not been maintained, and it is a most essential point. Take for example the three-wire circuit A D, C E, B F. Let R be the resistance of cable A D, R″ the resistance of cable C E, R′ the resistance of cable B F, I and I′ the currents flowing in the two circuits, m, m', the difference of potential in D E and E F, we then have the following:



$$m = 120 - R\,I - R''\,I + R''\,I' \quad (1)$$

$$m' = 120 - R'\,I' - R''\,I' + R''\,I \quad (2)$$

For instance, suppose that $I' = 0$ and that I is of constant value, we shall then have the following relations:

(1) $$m = 120 - R\,I - R''\,I$$

(2) $$m' = 120 + R''\,I.$$

The difference in potential between the points D and E will be less than 120 volts, and it will be greater than 120 volts between points E and F. But in circuits of 120 volts, 10 volts are allowed for loss of pressure, and the regulating resistance coils are calculated to give 110 volts at the terminals of the line, even when using a small current. If the resistance is not increased, and if equilibrium is not obtained on the two lines, a difference of potential will occur which is greater than the normal difference.

REMARKS ON THE LAUFFEN-FRANKFORT EXPERIMENTS.

[FROM OUR OWN CORRESPONDENT.]

IN No. 690 of your valued paper, p. 212, I expressed the view that experiments made on January 24th of last year at Oerlikon, which served as a prelude to the Lauffen-Frankfort experiments, and which were praised in the daily Press, and characterised as decidedly successful, by no means afforded a technically valid proof of what was to be shown by these pompously executed trials, *i.e.*, that it is practically and usefully possible, with the means now available, to convey a current of 30,000 volts to a distance of 180 kilometres, and with this current to effect permanent and regular industrial operations.

In the meantime there has occurred, as the sequel to these experiments, the extensive Lauffen-Frankfort transfer of power, which has excited in the widest circles an interest no less warm than justifiable. The project has been displayed to the numerous visitors to the Frankfort Exhibition under the most favourable auspices. Still to-day, according to the official conclusions of the exhibition, it is declared, as the result of this magnificent experiment, that the hopes entertained have been by no means fulfilled, and have in particular led to no practically tangible outcome. In other words, nothing has been brought to light by the results of the Lauffen-Frankfort transfer of power which can induce industrialists to utilise these experiments as the basis of extensive manufacturing undertakings.

We must especially remember that the Lauffen-Frankfort experiments were intended to demonstrate the practical applicability not only of high tension, but also of the rotatory current, and that these experiments were most closely connected with the idea of the rotatory current, so that it became customary to speak of the Lauffen-Frankfort installation as a rotatory current installation, and in consequence, to speak briefly of the Lauffen-Frankfort rotatory current installation.

Although the entire German Press during the whole time of the exhibition had nothing to say about these experiments save praises, peculiarly enough nothing can be drawn from all these reports upon which a practical man can found an opinion on the industrial applicability of the rotatory current for permanent work.

Scarcely was the Frankfort Exhibition concluded when Herr Brown, who was known and recognised as the true originator of the Oerlikon experiments, and in consequence also of the Lauffen-Frankfort transfer of power, came forward with the surprising declaration that the application of the rotatory current in the above-mentioned installation did not correspond with the original programme, and that this innovation merely impeded the Lauffen-Frankfort experiment without assisting it in any manner, and that the installation would have acted much more simply and successfully *if a plain alternating current had been used instead of the rotatory current*. The great public was thus undeceived.

Hence the Lauffen Frankfort installation, announced with such bombast, shrivels up to a very modest experiment concerning the use of alternating currents at higher tensions than had been heretofore practically used. In this position of affairs the assertion cannot be contradicted that the transfer of power from Lauffen to Frankfort was an experiment without results. For if we ask what new result had come of an undertaking blazoned forth with such high-sounding words, we arrive at the conclusion that nothing is to be found.

The conduction of the current to great distances is a matter which has long been known. The transformation of electric currents has also been known for years, and has been in many cases carried out with success. The use of alternating currents for motive purposes is also not new.

The novelty which the undertakers of the vaunted experiment proposed to furnish, *i.e.*, the use of a current of the tension of 30,000 volts (which had hitherto not been done, and by which alone it would have been possible to convey the current to so great a distance in an economical and therefore industrially useful manner) has failed, for the Lauffen-Frankfort experiments with high tensions did not possess the character of a permanent industrial experiment, but rather

that of a laboratory experiment on a scale previously unheard of. Hence the value of this trial must be regarded as decidedly problematical.

As to the high tension in particular, it is a fact that during the entire duration of the exhibition the electromotive experiments were conducted with a tension far below the proposed 30,000 volts. Only towards the close of the exhibition, as the public was informed in newspaper paragraphs, experiments were made at a tension of 27,500 volts. But these experiments were only of brief duration, so that here, also, there is nothing having the character of permanent work. The experiments were, so to speak, only momentary, and can lay no claim to afford an insight into industrial undertakings.

The experiments were either concluded too early, or they must in this respect be considered as a failure. In any case, in the present position of affairs, the value of the Frankfort demonstrations must be pronounced highly problematical.

SOME CURVES FROM ALTERNATING-CURRENT MACHINES.*

By WARREN B. LEWIS.

THE unusual number of experiments which have been made within a year or two upon the characteristic curves of currents as obtained from different types of dynamos, led the writer to attempt a few investigations in the same line, upon some alternating machines of special design. Taken in connection with preceding results, which have been published from time to time, they afford a most interesting study of dynamo electric machines of this class, and give a more or less complete record of the peculiarities which may be obtained by different dispositions of iron and copper.

The applications of alternating currents to methods of

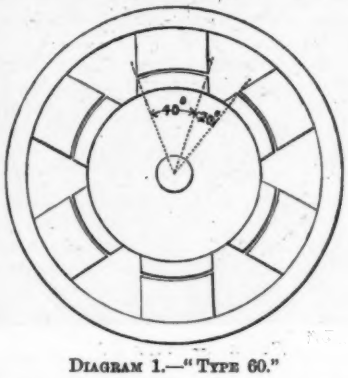


DIAGRAM 1.—"TYPE 60."

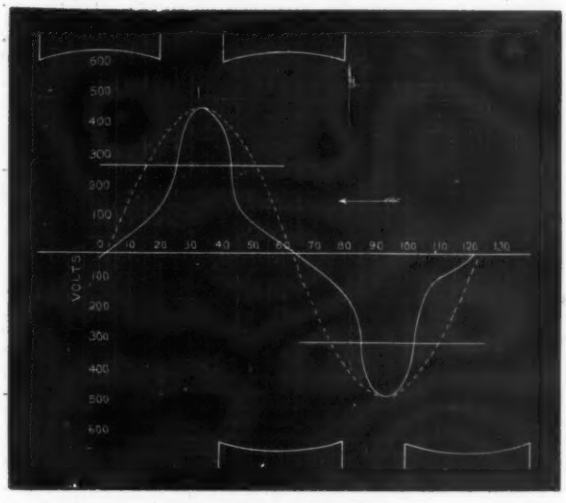
heating, smelting, and other processes in which currents of immense volume are employed, has led to a class of apparatus considerably different from that which is so generally known and used for lighting. In the transmission of these currents, obstacles have arisen, which have been satisfactorily overcome only after considerable experimenting. The adaptability of the transformer to such processes has led to a large number of interesting experiments and developments and has called for a dynamo to be used in connection with these transformers which possesses peculiarities not found in other types.

A combination of mechanical and electrical requirements has imposed conditions, some of which, if understood at the outset, may lead to a better comprehension of the results which follow.

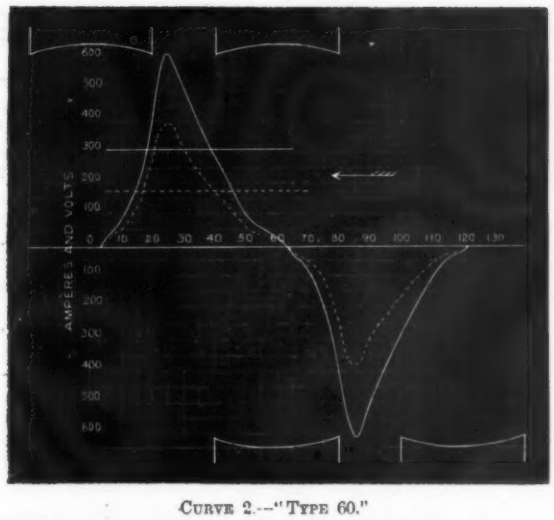
In the construction of the transformer, it has been found preferable, for many reasons, to make the secondary a large copper casting, which generally means a more or less solid mass of metal; but, in transmitting currents of several thousands of ampères, there is made evident the fact that the superficial area is of the greatest importance, and that the interior mass is of little use. This phenomenon being dependent largely upon the rate of alternations, the system could be made more efficient by using a low periodicity.

*Electrical World, New York.

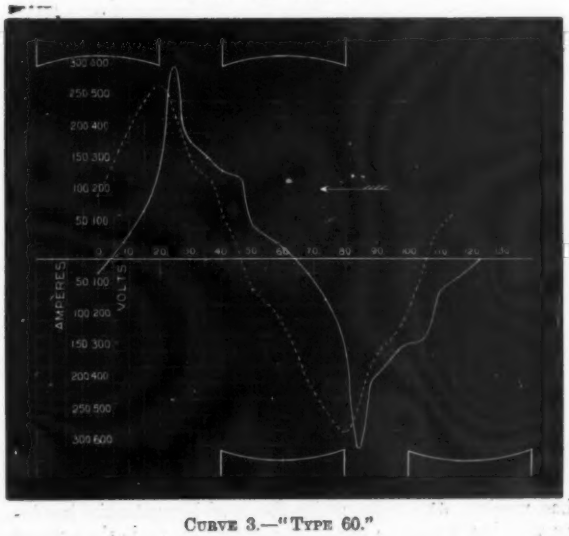
The requisite induction in the armature wires can be obtained by causing a very rapid change in the magnetic circuit at some instant; and in the machines under observa-



CURVE 1.—"TYPE 60."



CURVE 2.—"TYPE 60."



CURVE 3.—"TYPE 60."

tion this is so well done that only a remarkably small amount of wire is used. One would naturally expect that with an abnormal rate of change in the magnetic circuit at one point, a slower change would occur at some other place, and that the result would be a curve rather far re-

moved from the typical sine curve. How closely the theory is proved by practice will be seen by reference to the curves.

The periodicity adopted was 50 per second, obtained from four and six-pole machines. The two machines which were principally used in the trials are both six-pole, but of different designs as to the angular width of the pole pieces. The armatures of both are solid, with the exception of the ventilating holes, and have pole pieces corresponding to the field poles. The armature wire is wound in rectangular coils and put over the poles so as to surround them.

One machine, which will be designated as a "60," was a 60,000 watt dynamo of the composite type. A certain proportion of the armature current is commutated, and flows through the field wire in series with the current of a small exciter dynamo. The proportion commutated is dependent upon the ratio of the resistance of the exciting circuit to a shunt placed outside of the machine, and connected to a third collector ring.

Another machine was a separately excited dynamo, rated at 40,000 watts, and will be designated as a "40." This machine differs from the preceding in the angular width of the pole pieces and the shape of the grooves in the armature core. The third was a separately excited alternator, the armature having no iron, and will be designated as a "50."

In connection with each set of curves a small diagram is given, showing the relative dimensions of the various parts, and their angular positions. A description of the apparatus used is hardly necessary, as the same arrangements have been described in previous papers. The galvanometer was a ballistic one, designed and constructed for the occasion, and gave excellent results.

In all the curves, the abscissæ are actual degrees about the shaft of the machine, and ordinates the volts and ampères as marked. The position of the field poles with relation to the centre of the armature coil is also shown at the top and bottom of curves, 1, 2, 3, 4, 5, 6, and by the dotted ovals in curve 7.

Curves 1, 2, 3 are of the type "60." The angular width of the pole pieces is shown in diagram 1 to be 40 degrees, and the space between them 20 degrees. The direction of rotation of the armature is indicated in each curve by an arrow.

In curve 1, the full line is the potential curve, the dynamo running on no load. The dotted curve is a sine, and is drawn to more forcibly illustrate the approach of the potential curve to a "saw tooth." The features which become noticeable are the regularity of the curve and its maximum E.M.F. which is about 468 volts: the working potential, as read on a Cardew voltmeter, being 296 volts, shown by a straight line. The field magnets required 386 watts, which were supplied by the small exciter alone, evidently.

Observe now curve 2. The dynamo is loaded on a water rheostat to a little over 52,000 watts, the field requiring 635 watts, or about 1·2 per cent. The regularity of the curve has been considerably disturbed, and the maximum point

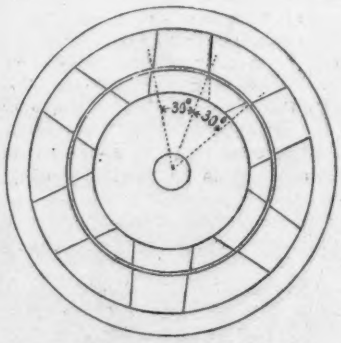
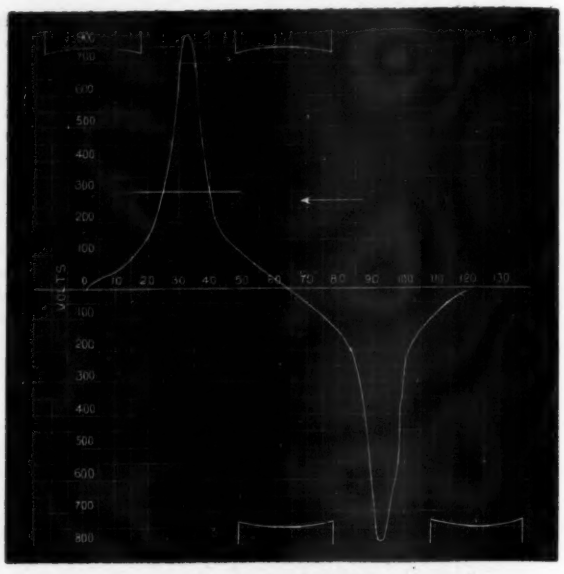
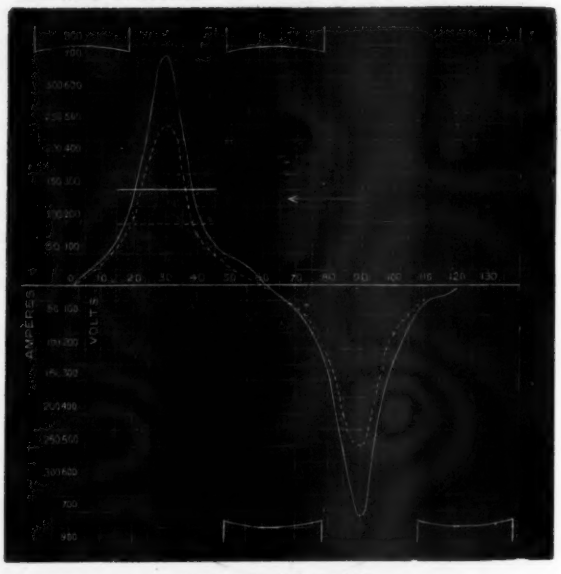


DIAGRAM 2.—"TYPE 40."

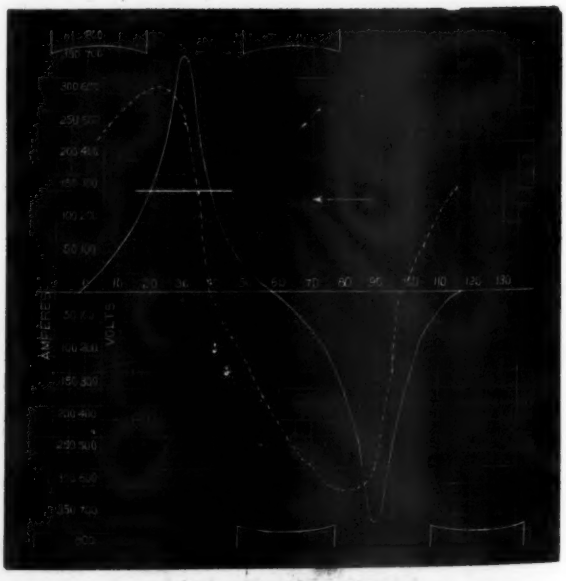
has reached 615 volts, while the working potential has increased but 8 volts to 304. The dotted curve is the current curve, the straight dotted line the current as read on an ammeter, both drawn to the same scale as the potential curve. This makes rather a curious curve when compared with curve 1, but graphically illustrates the change in the magnetic circuit very clearly—the sudden jumping away from the armature of the magnetic lines from the receding poles, and



CURVE 4.—"TYPE 40."

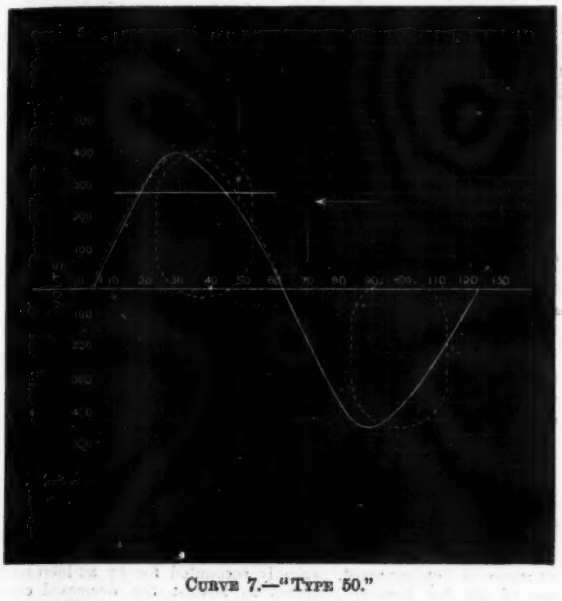


CURVE 5.—"TYPE 40."



CURVE 6.—"TYPE 40."

the leap to the armature of the lines from the approaching poles. But the peculiarity becomes greater when the load is an inductive one. Curve 3 is such a load, the actual power being 34,500 watts. The maximum E.M.F. is the same as when a non-inductive load was used, and the side of the curve in the direction of rotation is not greatly changed; but the remaining part of the curve baffles description. The current curve is quite regular, and approaches a sine curve, which is what an inductive load tends to produce, as is well known. The field magnets use 826 watts, or 2·4 per cent. of the output.



CURVE 7.—"TYPE 50."

Referring now to curves 4, 5, 6, we see the effect of narrowing the pole pieces. This machine is the type "40," and the pole pieces, as shown in diagram 2, are but 30 degrees in width. The working potential being practically the same as in the case of the "60," namely 300 volts, the maximum attained is 790 volts, with a position exactly midway between the poles, and very rapidly falling off, about equally on either side. It may be interesting to note the matter of insulation which this curve brings out. Although 300 volts is the working potential, the machine should be insulated for 800. As a fact, these dynamos are now insulated to withstand a potential of 1,800 volts.

Curve 5 represents a non-inductive load of 34,000 watts, the fields using 936 watts. The angular position of the maximum point has advanced, but the regularity is still preserved, with the exception of a few degrees near the zero line on one side. The curve has broadened, too, with a consequent drop in the maximum E.M.F. As would naturally be expected, the current curve follows the potential curve

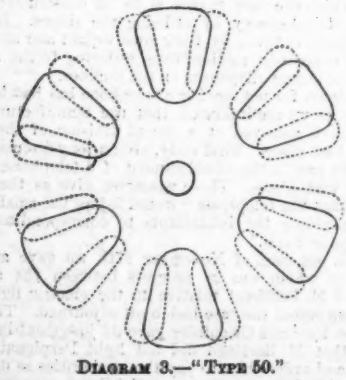


DIAGRAM 3.—"TYPE 50."

PERFORMANCE OF ALTERNATING CURRENT DYNAMOS.

very closely. Curve 6 was taken when the dynamo was loaded with an inductive resistance, the same as in curve 3. The actual power was 37,000 watts, with 1,140 used in the fields. Notice that the current lags somewhat more than in the "60."

Curve 7 was made principally to show how far removed in character two machines of so different design could be. Diagram 3 shows the relation of armature and field, the dotted ovals being the field poles, and the full lines the armature coils. The dotted curve in curve 7 is a sine and serves to show how near the curve of the dynamo in question approaches it. Compare this with curve 4, and a greater difference could hardly be imagined.

Unfortunately, at this point, circumstances prevented the continuation of the experiments, and it is a matter of regret that further curves could not be taken on the last machine. A few rough experiments were made to determine the reaction of an armature pole upon a field pole, when the dynamo was carrying its full load, but the effect was so small that special arrangements would have had to be made, and for lack of opportunity the work was discontinued.

A very interesting study may be made by recalling the curves made by Messrs. Tobey and Walbridge,* on the "Stanley Arc Alternating Current Machine," and comparing them with those given in the preceding.

It may not be out of place to add that the two machines upon which the foregoing experiments were made are very efficient and well suited to the purpose. Loads, up to their full capacity, are thrown on and off at brief intervals, with no difficulty, and with hardly a noticeable change in the potential.

NOTTING HILL ELECTRIC LIGHTING.

THIS week there has been some correspondence appearing in the *Financial News* regarding the electric lighting in the West End, for which the Notting Hill Electric Light Company have powers. The writer of the letters says some hard things concerning the negligent treatment which he has received from this company, and we ourselves must express great surprise that the company should not be more awake to its own interests than to have such conduct to account for as that which the correspondent, signing himself "Palace Gardens Terrace," attributes to them. He says that in October last year, Messrs. Spagnoletti and Crookes's representatives called on him, as being the engineers of the Notting Hill Company, and solicited the order for the wiring of his house for the purpose of enabling him to use the electric light. He accordingly, placing faith in their definite assurances, accepted their tender in December—now just twelve months ago—and had the men at work for several weeks. He, fortunately, was wise in stipulating that he should not pay for the cost of wiring until current was supplied.

During the past 12 months he has been continually writing, asking when the current might be expected, and they have promised time after time that it would be supplied immediately. He eventually packed up and went abroad, expecting to find the current supplied when he returned, but was disappointed. Last September Messrs. Spagnoletti and Crookes asked him to pay the bill at once, and pressed him several times, but he naturally and justly refused payment on the ground of the clause in his agreement. In reply to his letter refusing to pay the amount, he received a most unbusinesslike letter, which reveals a course of action liable to injure the reputation of any company which had entered into a similar contract. The following is an extract from this letter:—

"The board has decided, as a matter of principle, that they are willing to extend the mains to the house of any consumers, provided that they will subscribe for an amount of shares sufficient to cover the cost.

"Should you, in your own name, or in the names of nominees, apply for 35 £10 shares in this company, the board would undertake to spend the money in making the extension forthwith.

"Should you not decide to take this course, the joining up of your house will only be able to be done when we make

* See *The Electrical World*, November 8th, 1890.

our extension into the district, and this depends on raising fresh capital."

We quite agree with the course the complainant is taking when he replies that he must refuse the company's offer. What right has any firm, electric lighting or otherwise, to solicit definite orders until they are in a position, or at any rate are able to clearly see their way, to execute the work without delay? If people are to be inconvenienced in such a manner as this, there is no wonder that they are reluctant to place orders for their houses to be fitted with the modern illuminant. Surely "Palace Gardens Terrace" is entitled to some compensation for the expense and trouble to which he has been put. Is the company trying to force its shares upon the public, or is it difficult to get subscribers for them, as the complainant states that he can purchase the shares at a cost below their nominal value of £10 each. We fully sympathise with the inhabitant of "Palace Gardens Terrace," and hope that he will soon have his orders promptly carried out.

REVIEWS.

Popular Electric Lighting; with a chapter on electric motors. By Captain E. IRONSIDE BAX. London: Biggs and Co., 139, 140, Salisbury Court.

The author of this book is general manager of the Westminster Electric Supply Corporation, and is presumably, therefore, well able to deal with the subject he writes about. The book commences with a glossary of terms in general use amongst the electric lighting community, and is intended for those who have no knowledge of electricity. The writer, in advocating the low tension system, is careful to exclude any explanation of any advantages which the high tension may possess; hence, by giving an entirely one-sided view of the question, he is able to say, "It is therefore clear that the low tension system is to be preferred to the high." We may be inclined to agree with the writer, because we know something about the arguments on both sides, but the public does not, and is not enlightened on the subject.

The general mass of information given does not call for comment; it is well written, in a popular style, and explains very clearly the general points in connection with electric lighting; in fact, any one of the general public taking up the book and reading it should be able to judge fairly of the advantages of the light and the necessity of having good work put in in connection with the same. The all-important question of cost is dealt with in an appendix, the cost of fittings for houses of various sizes being given, and also the probable annual cost of the current at 8d. per unit. The chapter on "Electric Motors" shows the many uses to which these machines may be put in private houses and factories, and which an electric supply renders available. In connection with this particular subject we would draw attention to a point which often seems to be overlooked in dealing with motive power, and that is that when the latter is supplied from steam or gas engines on the premises the rental of the space occupied by the plant may so run up the total expenses that the latter may considerably exceed the rental charged for the same amount of electrical power supplied by an outside company, the electric motor itself occupying but very little room. We may add that the outside of the book is very attractive.

Condensed Mechanics: A Selection of Formulæ, Rules, Tables, and Data for the Use of Engineering Students, Science Classes, &c., in accordance with the requirements of the Science and Art Department. By W. G. CRAWFORD HUGHES. London: Crosby Lockwood and Son, Stationers' Hall Court, Ludgate Hill.

This book contains an exceedingly well selected collection of formulæ, with examples to the same, and should prove very useful as a work of reference, not only for students but for practical engineers. A few more sub-headings would have been advantageous, though the bold style in which the printing is done and spaced renders this to some extent unnecessary.

The "Practical Engineer" Pocket-Book and Diary, 1892. London: Technical Publishing Company, Limited, 1, Paternoster Buildings.

The present issue of this useful pocket book is a great advance of previous issues, a large amount of new matter having been added; it should prove especially useful to mechanical engineers.

The Mechanical World Pocket Diary, 1892. London: *Mechanical World* office, 325, Strand.

This book is much of the same nature as the foregoing, and is now in its fifth year of publication. For the price (6d.), the amount of matter given is exceedingly large, and it is very well arranged.

FRENCH ELECTRICAL NOTES.

THE Berlier electric underground railway scheme, to which we have referred in a former number of the REVIEW, appears likely to meet with considerable opposition. A petition has just been presented to the Paris Municipal Council by M. Lamouroux, who represents the Saint Germain l'Auxerrois quarter, which the tradesmen in the Rues de Rivoli and Saint Antoine, over 1,200 in number, have almost unanimously signed for "the defence of their thoroughfares against the Berlier subterranean tramway project." This is almost on all-fours with the opposition of the Oxford Street tradesmen to the Central London Electric Railway scheme.

The general report of M. Strauss on the Budget of 1892 was last week discussed by the Paris Municipal Council. In this report, from calculations made by the engineers, an enormous decrease in gas receipts is likely to ensue, a decrease from 20,000,000 francs at present to 7,000,000 francs in 1905. For 1890 and 1891, however, this decrease is not apparent, probably accounted for by an increased use of gas for heating purposes as against the decreased consumption of lighting gas. Referring to the electric light, the report states that the incandescent lights, which in April, 1890, numbered 22,000, in July, 1891, amounted to 63,500, and, seeing this increase, it is certainly wise to predict a decreased consumption of gas. In connection with the telephone lines and their use of the sewers, the State refuses to pay anything, although the cleaning of the sewers is greatly complicated by the telephone lines. The council accordingly claims, since 1886, an indemnity of 50 francs for the first kilometre, 40 francs for the second, 30 for the third, 20 francs for the fourth, and 10 francs for succeeding kilometres. The case will be shortly heard in the Courts.

Last week (December 3rd) saw the opening of the Popp Company's new station on the Quai de la Gare. This station has been built with the view to an installation of 20,000 horse-power. On the opening day three engines of 2,000 horse-power each were started; while a fourth, of the same power, is to be set at work a fortnight later, and the remainder in proportion to the company's requirements. The works, we may mention (despite the most embittered attacks against the company and its directors), have been completed in 18 months.

Efforts are being made on the French railways to substitute electric traction for steam. One scheme is that invented by M. J. J. Heilmann, and financed by the Société de la Traction Electrique, of Paris; while the Northern Railway will shortly perform a series of experiments with an electric locomotive, the first trials of which will be made on the Paris-St. Denis line, and afterwards, if the trials are successful, on that from Calais to Paris. The principle on which the new engine is to be constructed will be the renewal of electrical energy by utilising the slopes. In making the descent, the trains running by their own weight and acquired speed, will set the dynamos in motion, thus restoring to the accumulators a portion of the energy dispensed on the inclines.

A curious reason for not having a telephone has just been given at Limoges, whence we are informed that the manufacturers and merchants are much annoyed at a recent decision of the Chamber of Commerce of that place. That body, after a long discussion, formally refused to take part in the establishment of a telephone line connecting Limoges with Paris. These wiseacres give as their reason for this decision that the telephone "would injure the smaller traders in the town by enabling the inhabitants to correspond too easily with the large shops in Paris."

In a Note in our issue of November 27th we gave an account of some litigation which was in progress between the authorities of Perpignan and M. Bartissol relative to the electric lighting of that place, when we stated the case had been adjourned. The Prefecture Council of the Pyrénées Orientales gave its judgment last week, finding therein that M. Bartissol did not light Perpignan according to his contract, and orders him to pay the authorities as damages a sum representing the difference between lighting by gas and lighting by electricity, or 15,540 francs 26 centimes, and this from May 1st, 1890, the said sum to be payable per year till the installation of public lighting by electricity is completed and its working assured. The rights of action of the authorities are reserved against M. Bartissol in

case the agreement is not executed conformably to the clauses of the said agreement. The authorities themselves are ordered to pay M. Bartissol 15,415 francs, the cost of supplying the electric light to the theatre during the industrial exhibition of last year. This sum had not been paid him on account of the shaky state of the town's finances. M. Bartissol, it is understood, will appeal to the Council of State against the verdict.

LONDON COUNTY COUNCIL.

AT the usual weekly meeting held last Tuesday the following was submitted:—

St. Pancras Vestry—Loan for Electric Lighting Works.

The council on December 1st, having agreed to sanction the borrowing by the Vestry of St. Pancras of the sum of £60,000 for carrying out electric lighting works, it is requisite that a formal order should be sealed to give effect to that resolution. We submit a form of order in duplicate, and recommend that the seal of the council be affixed thereto.

London Overhead Wires Act, 1891.

By section 5 of the London Overhead Wires Act, 1891, the council is empowered to make and vary bye-laws with respect to (*a*) the identification of overhead wires by registration or otherwise; (*b*) the regulation of wires; (*c*) the strength of the materials to be employed in placing, maintaining, and supporting wires; and (*d*) the removal of wires erected or placed otherwise than in accordance with such bye-laws and of disused wires; and the council may by such bye-laws fix and determine the penalties to be imposed on the company or person failing to comply with any of the provisions of the Act, and continuing penalties in the event of any such offence being continued after conviction thereof. These bye-laws are, however, to be of no effect until approved by the Board of Trade, which department is to prescribe to whom and in what manner notices of the intended bye-laws shall be given; and it is further provided that, before such bye-laws are proposed to the Board for confirmation, notice thereof, with copies of the intended bye-laws, is to be given to the Postmaster-General. The general administration of the Act, and the enforcement of the bye-laws when made by the council and confirmed by the Board of Trade, devolve upon the local authorities, *i.e.*, within the City of London, the Commissioners of Sewers, and outside the City, the vestries and district boards, except as regards any street, road, embankment, bridge, park, garden, or open space vested in the council where the council is itself the local authority. We have prepared a series of bye-laws (a copy of which has been sent to each member of the council), and the Board of Trade has prescribed to whom and in what manner the notices of the intended bye-laws shall be given. It is probable that some exception may be taken, by companies and others interested, to some of the provisions contained in these bye-laws; and we are of opinion that we should have instructions to consider any suggested alterations, and to represent the council before the Board of Trade. We recommend that the draft bye-laws under the London Overhead Wires Act, 1891, be approved, and that it be referred to the Highways Committee to issue notices and to take all other necessary measures to obtain the confirmation of the bye-laws, including, should the committee consider it advisable, the employment of counsel to support the bye-laws before the Board of Trade.

Subways Bill.

In preparing this Bill we have endeavoured to carry out the resolution of the council on June 9th last, instructing us to prepare a Bill giving the council power to require companies and others to lay their pipes, &c., in the existing subways, and to pay the council a rent for such use. The Bill also, as directed by the council on November 3rd last, contains provisions for giving the council power to make bye-laws and regulations with reference to the use of its subways, existing or hereafter to be constructed, and imposing penalties for the breach of such bye-laws and regulations. We do not, however, think that the Bill is satisfactory. The rights of electric lighting companies as to wires have been recently settled under the Electric Lighting Acts, and as regards all overhead wires the council have large powers of regulation by bye-law under the Act of last session. It is difficult, therefore, to see what case can be made out to justify any disturbance of legislation so recent. On the other hand, unless these wires are to be dealt with, is there a case for *any* Bill? As regards any new subways made under powers of any future Act of Parliament, the extent and terms of their use would properly be dealt with by such future Act. As regards existing subways, the companies were subjected to no rent by the Acts which authorised them. We have, however, no such detailed information on the difficulties which exist and the precise mode proposed to remedy them as to enable us to express any very decided opinion on the matter. The subject certainly requires careful consideration, as any such Bill must of course be strongly opposed by all the water, gas, electric, telephonic, and other companies, and persons having power to lay pipes and wires. However, the references to us do not appear to leave us any discretion as to the advisability or otherwise of proceeding with the matter, and we have accordingly taken the best steps in our power to carry out the instructions of the council. A copy of the Bill has been sent to each member of the council, and we recommend that the Subways Bill be approved; that the seal of the council be affixed to the petition for leave to bring in the Bill; and that the Bill and petition be deposited, pursuant to the standing orders of Parliament, with such verbal alterations, if any, as the Parliamentary Committee may consider desirable.

Standard of Light.

On July 28th last, the council, on the recommendation of the Sanitary Committee, resolved to introduce a Bill in the next session of Parliament for substituting a more exact standard of light for that now prescribed by the principal Gas Companies' Acts, and referred it to us to take the necessary steps for this purpose. It will be remembered that the Sanitary Committee submitted a further report on this subject on October 13th, referring to the endeavours made to secure the appointment of a scientific committee to consider what the standard of light should be, and stating that in the absence of an authoritative decision on this point, it might be useless to promote a Bill. As the Sanitary Committee were in communication with the Board of Trade we thought it advisable to postpone the consideration of the matter pending a reply from that department. Eventually it was intimated that steps would be taken for the appointment of a committee, and the Sanitary Committee, at our request, furnished us with a memorandum explaining the object sought to be attained by the Bill, and also sent us the draft of a Bill on the subject. These we referred to the agent, and as time pressed, instructed him to prepare and issue the necessary notice for a private Bill, if he thought such a course desirable and practicable. The agent is quite of opinion that, the proper mode of procedure is by a private Bill or Bills to amend the existing Acts of the gas companies, but he has pointed out to us that the whole procedure of private Bill legislation under the standing orders of Parliament is based on the assumption that clear notice should be given of enactments affecting particular interests, and that the Bill should clearly define the enactment required, so that the parties affected may have adequate time and opportunity for considering the case, and stating in detail in their petition to Parliament their objections and arguments against the Bill; and he does not think that any private Bill could be properly framed dealing with this subject, unless the nature of the new tests suggested were described therein. Therefore, as it is impossible to define the standard of light until the proposed committee has reported, the agent thought it better not to publish any notice. We entirely approve the course which he has taken, and we recommend that further action in the direction of obtaining legislative authority for a more exact standard of light be deferred for the present.

LEGAL.

Anglo-American Brush Electric Light Corporation v. King, Brown & Co. (*continued from* p. 647).—Appeal case in the House of Lords.

The ATTORNEY-GENERAL continued his address on Thursday, last week, on behalf of the appellants, and did not conclude until Monday noon. The first part of the speech was an attempt to describe to their Lordships the working parts of dynamo machines at the time of the Brush patents. The Attorney-General emphasised the necessity of their Lordships realising the state of knowledge which existed at the time the patent was taken out, for when the case came originally before the Scotch Courts, it had been no part of the pursuer's evidence to bring into great relief that state of knowledge; that their Lordships should be assisted to estimate this the Attorney-General quoted lengthily from the evidence of the expert witnesses.

The ATTORNEY-GENERAL said that whatever might be the merits of Varley's anticipation, he showed the people no way of making the machine. Brush, on the other hand, gave most elaborate directions as to how the machine was to be wound, and separate circuits were to be made. He (the Attorney-General) was going to contend that it was not the intention of Varley to convey to the public or to the working man the shunt series arrangement; it was a mere incidental description of a principle which Varley was describing with another purpose. He asked their Lordships to be extremely careful not to construe the few sentences in Varley's description—directed, as he could show, to other improvements—into an enunciation of what was said to be shunt series working. Varley's anticipation led to no practical results; the machine was used by him under such circumstances that, but for the publication of the specification, it would be justifiable to say experimental use. The machine was afterwards thrown aside, and only produced for the purposes of litigation.

The continuation of the evidence of Prof. Silvanus Thompson on the state of knowledge of shunt machines, called forth the remark from Lord Herschell that the evidence showed how ignorant people—who might be expected to know—really were. The Attorney-General went on to say that it must be taken that shunt was known prior to the date of either Varley or Brush. He next went on to consider Varley's specification, and said if shunt series was new, what did Varley mean by saying that there were several well-known ways of making it? He urged that it was necessary to consider the whole of the specification together, and not to take out a particular passage. With reference to this particular passage, Sir William Thomson had pointed out that unless they read it separate from the direction of carrying it on it could not be understood, and if they thus read it separate there were no directions as to how the machine was to be made.

A long discussion ensued at this point between their Lordships and counsel as to the construction of this passage, the Attorney-General entering into a long argument on the unfairness of picking out a certain passage, and he submitted that, regarding the whole of the language used, that Varley meant something quite different from compound-winding. He next approached—with some hesitation—the evidence of the witnesses in regard to Varley's specification; for the construc-

tion of the specification was for the Court, and not for the witnesses. His view was that when the Court understood the true construction of that specification, it would be considered that no person would be led to admit that it described *shunt-series*. The evidence of the witnesses was then read at considerable length, emphasis being laid on the fact that no drawing was made in the specification of the compound machine. Coming to the question of user, it was contended that the machine was used for experimental purposes, altered after it was used, and used again for producing a light while photography took place, and for the purpose of showing to people. It was never used as a proper working machine, and, on account of the mechanical defects, could not be treated otherwise than an experimental machine.

Lord HERSCHELL here pointed out that neither Varley nor Brush put series-shunt in the foreground, but both used it preferably.

Lord WATSON remarked that great similarity existed between the two patents.

This gave occasion for a discussion, but

The ATTORNEY-GENERAL could not quite accept their lordships' views.

On the court resuming the sitting on Friday morning,

The ATTORNEY-GENERAL continued his address on the anticipation of the specification. He protested vigorously against the doctrine, as he termed it, of taking the specification and the machine together. If they had to enquire into what Varley meant it might be material to consider what the machine actually was; but for the purpose of anticipation the specification and the machines never were together. He submitted that the defects of the specification as instructions were not to be met by the fact that the inventor had used one machine according to this specification. There was unquestionable evidence that the machine itself was experimental in the truest sense of the word; in so far as publication was concerned it never passed beyond this stage. If they looked at the machine itself there was overwhelming evidence that it ought to be regarded as no anticipation, on the grounds that it was used experimentally and abandoned. He would here point out, as a commentary upon his argument, that while a number of Brush machines had been made with the compensating arrangement, Varley's machine went on to the scrap heap. The Attorney-General then quoted extracts from Prof. Silvanus Thompson's evidence, the use of which was not quite obvious to Lord Herschell. At this point the evidence of Prof. Perry was taken, the object of the counsel apparently being to show the mode of coupling used. Sir Wm. Thomson's evidence was taken to show that Varley's machine was purely experimental.

A question then arose between Lord Herschell and the Attorney-General as to the using of the machine. The Attorney-General argued that the machine had been altered many times, but, said Lord Herschell, there is no evidence to show that it was not used each time as a shunt series machine; even the cross-examination did not make Varley admit that it was used otherwise than a series shunt. After this came the further evidence of Sir Wm. Thomson and the evidence of Mr. Preece, which showed Varley's machine to be defective and uneconomical. Lord Herschell did not see how this evidence affected the case, remarking that although Varley's machine might be poor in parts, it did not touch the main question of the machine being made as a shunt series one.

The judgment of Lord Trayner was considered by the appellants' counsel to be simply based on the particular passage of Varley's specification. The Inner House, he said, would not accept Lord Trayner's views as to disconformity.

After the reading of the judgment the House adjourned until Monday morning.

On resuming on Monday morning, the ATTORNEY-GENERAL held that regarding the rules laid down in the House of Lords, Varley's patent did not disclose an invention. He went on to say that there was no doubt that Varley intended to have more than one circuit in his arrangement. After quoting from many judgments on patent law, the Attorney-General said he never disputed that Mr. Varley knew that the shunt was used as a shunt series; but there was not the slightest evidence to show that anybody else knew. With regard to the experimental user, there was no evidence to show who was present at the time. After quoting from judgments as to the publication of a patent, he concluded his address by saying that the disclosure made by Brush in 1878 was the first, and was therefore a good patent. The Attorney-General resumed his seat after addressing the Court for four days. He was followed on the same side by

Mr. MOULTON, who, in rising, said he wished to ascertain what was the precise invention in question, and whether it was fully disclosed or not. He held that Varley disclosed nothing new, and added nothing to the stock of knowledge at that date, which stock of knowledge, it was admitted, did not include compound winding. Varley's method did not give the compensating arrangement which was the real value of compound winding.

Mr. MOULTON, continuing his comments on Varley's original specification, seemed anxious to point out that the only thing in Varley's machine was separate excitation; that, he added, was very familiar, and used by Gramme, Wilde, and others, in their machines. Varley had used language with which people who knew separate excitation would be quite satisfied. The specification disclosed nothing with regard to compound-winding. The actual source of the compound machine was, *de facto*, Brush, who had made machines of this description before the date of his patent.

At the conclusion of this address, their LORDSHIPS, after a short discussion, said they would inform the Solicitor-General for Scotland if they desired to hear his side of the case.

The case now stands adjourned.

International Cable Company v. Suren Hartmann and Company.—On Tuesday last Mr. Justice Mathew heard an action of the International Cable Company, Limited, *v.* Suren Hartmann & Co., which was brought to recover £1,250 for calls on 500 shares which the defendants had taken in the plaintiff company at, as was alleged, the instance of Henley's Telegraph Works Company, who were also parties to the action. The defendants claimed to have been indemnified by Henley's Company under the terms of an agreement which had reference to an anticipated order for the manufacture and laying of the cable. His Lordship held that the defendants were entitled to be indemnified by Henley's Company, at whose request the shares had been applied for; but there must be judgment for the plaintiff company for £1,000 and costs.

John Denby v. Ernest Scott & Mountain.—Lord Kyllachy, in the Court of Sessions, Edinburgh, gave judgment in this case on Wednesday last. It will be remembered that this action, fully reported in our columns at the time, was brought by Mr. John Denby, electrotyper, against Messrs. Ernest Scott & Mountain for breach of contract in regard to a dynamo supplied by the defenders, which machine the pursuers say did not do the work for which it was bought. Lord Kyllachy gave judgment in favour of Messrs. Scott, and held that the pursuers had failed to prove their case. We shall give the judgment fully in our next issue.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

ON THE SPECIFICATION OF INSULATED CONDUCTORS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.* By W. H. PREECE, F.R.S.

IT cannot be said that we have hitherto been happy in our mode of specifying the insulating properties of electric light cables and conductors. Standards of quality and modes of classification differ with every manufacturer. The practice of the submarine cable engineer has been continued by the electric light engineer, and cables are specified to give so many megohms per mile, irrespective of their dimensions or of the purpose to which they are to be applied, while efforts are rarely, if ever, made to verify the figures so prominently given in published tables. If tests were made, it would be found that if the results were true for one sized conductor, they would be absolutely untrue for another. In a submarine cable, or in insulated wires for underground work, telegraphic or telephonic, the size of the conductor and the thickness of insulating coating remains constant, so that it is perfectly permissible to specify that the insulation resistance shall be x megohms per mile; but in electric light leads the diameters vary in every part of a building: a continuous mile length is rarely or never used except in mains and feeders, and the same mode of specifying is meaningless. Moreover, it is wrong, for if a conductor of 1 mm. diameter gave an insulation resistance of 2,000 megohms per mile when covered with an insulator 1 mm. thick, a conductor of 10 mm. diameter covered to the same thickness would give only 332 megohms per mile, yet its efficiency would be the same; while, if it were constructed to give uniformly 2,000 megohms per mile, it would be absurdly constructed and wastefully paid for.

In designing an electric light lead we have to regard the insulating quality of the material to be used, and the potential differences it has to resist. Its mechanical merits we will neglect for the present. The quality of the material can be defined without reference to its form, and if it be, as it ought to be, of a uniform and consistent material, we want to know simply its *specific insulation* or its resistance to the passage of currents through it when subjected to potential differences.

SPECIFIC RESISTANCE.

The specific resistance (ρ) of conductors is thoroughly well known. The standard of reference is the resistance of a centimetre cube of some imaginary metal, whose resistance is one C.G.S. unit of resistance at 0° C. 1,000,000,000 (10^9) cms. of this imaginary metal 1 cm.^{2} section give an ohm.

The following table shows the specific resistance of various metals, together with their temperature coefficients:—

	Specific Resistance.	Temperature Coefficient per 1° C.
Silver	1,488	... ·00377
Copper (soft)	1,580	... ·00388
,, (hard)	1,616	... ·00388
Gold	2,036	... ·00388
Aluminium	2,881	... ·0039
Zinc	5,566	... ·00365
Platinum	8,957	... ·0034
Iron	9,611	... ·0048
Nickel	12,320	... —
Tin	13,070	... ·00365
Lead	19,420	... ·00387
German silver	20,710	... ·00044
Platinum-silver	24,120	... ·00031
Platinoid	32,907	... ·00022
Nickel-steel	78,080	... ·00093
Mercury	94,070	... ·00086

Divide 10^9 cms. by ρ, and we obtain in any metal the length in cms. of 1 cms.^{2} sectional area giving 1 ohm. Thus $\frac{10^9}{1,580} = 632,911$ cms. of

* Paper read last night, December 10th.

soft copper of that section, and this divided by 30·48 = 20,764·8 feet, or 6,921·6 yards, which give *one ohm*.

Again, $\frac{10^9}{94,070}$ = 10,630 cms. of mercury of 1 cm.² section, or 106·3 cms. of 1 mm.² give 1 ohm.

This table also implies that if we take a length of 10^9 cms. of any metal of 1 cm.² section, the number (ρ) indicates the resistance of that length in ohms. Thus, 10^9 cms. of soft copper of that section gives 1,580 ohms.

Conductivity in submarine cables (of the Post Office standard type) is specified as follows:—"Each conductor shall be formed of a strand of seven copper wires, all of equal diameter, shall weigh 107 lbs. per nautical mile, and shall at a temperature of 75° F. have a resistance not higher than 11·65 ohms or lower than 11·18 ohms per nautical mile."

The limits of resistance are defined in order to maintain the weight of the copper of the coils within a proper margin, and to secure the proper proportion between the metal and the dielectric. Improvement has recently taken place in the purity of the copper manufactured; the density is greater, and as a result we obtain coils which with our present mode of testing give a better result than that of Matthiessen's standard of pure copper. Coils giving 101 per cent. of pure copper are frequent, and 102 per cent. not uncommon. The manufacturers are prepared to supply pure copper; we therefore intend to abolish the percentage clause, and to abandon specifying anything but pure copper. But we must determine its specific gravity, for it appears clear that the high conductivity is due to greater density, and there is no reason to doubt the accuracy of Matthiessen's determination of the specific resistance of pure copper at a density of 8·90.

Specific Insulation.

The specific resistance of insulating materials is not so well known as that of conductors, and is very variable. Clark and Sabine (1871) adopted as a standard the resistance of a cube-knot of the insulator at 75° F. (24·2° C.). But this standard never came into use, though it was tacitly admitted in all calculations derived from cylindrical cores, using the knot as unit length, and it was confined solely to submarine cables. The *knot* itself is an improper term, for the knot is a velocity, and not a length. The proper term is a nautical mile (2,029 yards), abbreviated into *naut*. Now a knot is a "naut" per hour, and is a term confined to a class. Hence its use in any form as a general standard is out of the question. A cube-kilometre, or a cube-mile, would be a more convenient unit, but a cube-quadrant (10^9 cms.)³ is in harmony with our C.G.S. system of units now universally accepted. The *specific insulation* of any insulating material is given by the formula:—

$$\sigma = \frac{\rho\, l\, 2\,\pi}{\log_\epsilon \frac{D}{d}},$$

where ρ is the specific resistance in C.G.S. units of the dielectric of a cable whose length is l cms., and whose insulating sheathing has inner and outer diameters of d and D respectively (D and d being in any units). The specific resistance in the C.G.S. system being that of a cubic centimetre of the material, the dimension of such a unit gives an excessive numerical value: it reads as high as 10^{25}, C.G.S. units—a figure beyond our comprehension. A more practical dimension is the resistance of a cube whose side is 1,000,000,000 (10^9) cms., taken in megohms.

Since in this country it is usual (except in the case of submarine cables) to express insulation in megohms per statute mile, the specific insulation determined from this value will be given by the expression,

$$\sigma = \frac{R \times \cdot9144 \times \frac{1,760}{10,000,000} \times 2\,\pi}{\log_\epsilon \frac{D}{d}};$$

or, giving $2\,\pi$ its numerical value and substituting common for natural logarithms, we get the expression,

$$\sigma = \frac{R \times 4{\cdot}39}{\log \frac{D}{d}} + 10{,}000,^*$$

where R is the insulation resistance in megohms per statute mile.

* A simple approximation to this formula has been worked out by Mr. H. R. Kempe as follows:—

$$\text{Log}_\epsilon \frac{D}{d} = 2\left\{\frac{D-d}{D+d} + \frac{1}{3}\left(\frac{D-d}{D+d}\right)^3 + \frac{1}{5}\left(\frac{D-d}{D+d}\right)^5 + \ldots\right.$$

Now, if D and d do not differ largely, we may neglect all the terms after the first without considerable error; so that the expression,

$$\frac{\rho\, l\, 2\,\pi}{\log_\epsilon \frac{D}{d}}$$

becomes

$$\frac{\rho\, l\, \pi}{\frac{D-d}{D+d}};$$

or, substituting thickness, t, of material, we get,

$$\rho\, l\, \pi \cdot \frac{d+t}{t}$$

Inserting the numerical value of π, and making R the resistance per statute mile, we have,

The practical standard, then, of specific insulation which I propose to adopt is the resistance of an earth quadrant (1,000,000,000 cms.) cube of a certain insulating material which at 0° C. gives a resistance of 1 megohm.

In this sense the specific insulations (σ) of various materials, calculated from dimensions and resistances, but not corrected for temperature, are as follows:—

Material.	C.G.S. Units.	Proposed Standard. σ	Temperature.	Authority.
Air	∞	∞		
Mica	$8{\cdot}4 \times 10^{22}$	·084	20° C.	Ayrton & Perry.
Gutta-percha ...	$4{\cdot}5 \times 10^{23}$	·45	24° „	L. Clarke.
India-rubber ...	$1{\cdot}09 \times 10^{25}$	10·9	24° „	
Shellac	$9{\cdot}0 \times 10^{24}$	9	28° „	Ayrton & Perry.
Hooper's core ...	$1{\cdot}5 \times 10^{25}$	15	34° „	Tests.
Ebonite ...	$2{\cdot}8 \times 10^{25}$	28	46° „	Ayrton & Perry.
Paraffine ...	$3{\cdot}4 \times 10^{25}$	34	46° „	„ „
Glass (Flint) ...	$2{\cdot}0 \times 10^{25}$	20	20° „	T. Gray.
Siemens's special high insulating rubber	... ...	16·17	15° „	
Do. ordinary pure and vulcanised rubber	... ...	2·28	15° „	
Do. specially high insulating fibrous material	... ...	11·90	15° „	
Fowler-Waring dielectric... ...	... ...	7·33	15° „	
Glover vulcanised rubber ...	... ...	1·63	15° „	

To obtain the true value for σ these results, of course, ought to be corrected to 0° C.

Electrification.

Insulated conductors should always be subjected to the process of electrification for a certain period before the scale reading from which the insulation is to be calculated is noted. The leakage current polarises the dielectric; the insulation apparently improves—rapidly at first, then more slowly—and unless some conventional time were agreed upon for the test, proper comparisons could not be made. One minute is universally accepted as the period. The rate of fall due to electrification is a great test of the quality of the insulating material. It varies with the nature and quality of the material, being more marked at low temperatures. Unsteady electrification is a sign of an incipient fault, and perfectly regular electrification is an indication of good material. The resistance of the dielectric apparently gradually increases, owing to the formation of an opposing electromotive force in what is probably a liquid electrolyte. As the rate at at which electrification proceeds is an uncertain quantity, and in the best material is very low, it is better (except in special cases) to specify that the electrification shall progress steadily, without stating the rate at which it proceeds. The temperature at which the test is to be made should also, of course, be given, 75° being the usual standard.

Thickness of Insulation.

More important is it to determine and specify the thickness of the insulating coating. Two conditions determine this—the E.M.F. to be used, and the mechanical conditions of manufacture. We have also to consider sparking distances in air, especially in the case of high-pressure mains, when heat, age, accident, and use cause decay and cracks, and the conductor becomes exposed through fissures. I cannot contemplate a less thickness of any material than 1 mm., or ·04 of an inch, for a No. 19 wire. That means that a millimetre conductor requires as a minimum a millimetre thickness of insulating coating. Now the striking distance of a millimetre in air is over

$$\sigma = R \times 5{\cdot}0559 \times \frac{d+t}{t} + 10{,}000,$$

which may be written approximately (especially since we know that $\frac{d+t}{t}$ actually rather too large.

$$\sigma = R \times 5{\cdot}05 \times \frac{d+t}{t} + 10{,}000.$$

For general purposes the expression,

$$R \times 5 \times \frac{d+t}{t} + 10{,}000,$$

or

$$\frac{R \times \frac{d+t}{t}}{2{,}000},$$

will give sufficiently correct results, being within 1 per cent. of accuracy in most cases. Thus, taking D = ·5, d = ·314, R = 5,000 (the actual results obtained with a rubber insulated wire), then t = ·093: by the exact formula we have,

$$\sigma = \frac{5{,}000 \times 4{\cdot}39}{\log{\cdot}5 - \log{\cdot}314} + 10{,}000$$

$$= \frac{5{,}000 \times 4{\cdot}39}{1{\cdot}6989700 - \bar{1}{\cdot}4969296} + 10{,}000 = 10{\cdot}865.$$

By the approximate formula we get,

$$\frac{5{,}000 \times \frac{{\cdot}314 + {\cdot}093}{{\cdot}093}}{2{,}000} = 10{\cdot}941.$$

600 volts. As the conductor increases in diameter, the thickness must increase in greater ratio, not because the E.M.F. requires it but because the exigencies of manufacture and the mechanical construction of the core demand more stuff to resist the stresses brought to bear upon it. Given a conductor with a certain thickness of dielectric, able to resist the stress of x volts, the same thickness will equally resist the same voltage whatever the diameter or sectional area of the conductor.

The actual thickness to be used above the crucial thickness required for the security of those who accidentally or purposely handle the wire is a manufacturer's question; the engineer can specify only the minimum thickness. The Board of Trade rule for aerial conductors is the following:—

"Every high-pressure aerial conductor shall be continuously insulated with a durable and efficient material, to be approved by the Board of Trade, to a thickness of not less than one-tenth part of an inch; and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulation shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. This insulation shall be further efficiently protected on the outside against injury or removal by abrasion. If this protection be wholly or partly metallic, it shall be efficiently connected to earth.

"The material used for insulating any high-pressure aerial conductor shall be such as will not be liable to injurious change of physical structure or condition when exposed to any temperature between the limits of 0° and 150° Fah., or to contract with the ordinary atmosphere of towns or manufacturing districts."

The two points, then, to be met are those of specific insulation and of thickness; the former determining the quality of the material, and the latter being governed by the striking distance.

It is an extremely difficult thing to arrive at a definite conclusion as to the exact sparking distance across an air space with a given potential difference. It varies with the character of the opposing surfaces; with the resistance, capacity, and electro-magnetic inertia in the circuit; with the nature of the current—that is, whether it is steady or alternating, and also in the latter case with the frequency. Sir W. Thomson concludes "that a Daniell's battery of 5,510 elements can produce a spark between two slightly convex metallic surfaces at one-eighth of a centimetre asunder in ordinary atmospheric air" (Papers on "Electrostatics and Magnetism," page 259), which means that it requires 4,928 volts to strike across one millimetre.

Warren de la Rue obtained a result very similar. Prof. Crookes, using an induction coil, takes much lower figures, and estimates the striking E.M.F. at 1 mm. as 920 volts. Mr. Ferranti, using a frequency of 200, and 20,000 volts, brought the voltage down to 620.

I propose for underground and covered conductors to specify as a minimum for 500 volts or any E.M.F. under, 1 mm. thickness of dielectric, and ·5 mm. for each succeeding 500 volts or portion of 500 volts. This is shown as follows:—

THICKNESS OF DIELECTRIC FOR DIFFERENT VOLTAGES.

Voltage.	mm.	inch.	Board of Trade (inch.)
500	1	·04	·04
1,000	1·5	·06	·05
1,500	2	·08	·075
2,000	2·5	·10	·10
*2,500	3	·12	·125
*5,000	5·5	·22	·25
*10,000	10·5	·42	·5

* Material of superior quality, *i.e.*, σ over 10.

(To be continued.)

NOTES.

Personal.—We are informed that Mr. Sydney F. Walker has resigned the editorship of the electrical supplement of the *Iron and Coal Trades Review*.

Board of Trade Returns.—The Board of Trade returns for November again show a general and serious falling off in the exports. Amongst the items which contribute to the decline there appears telegraph wires, £221,235 decrease.

City Men at Home.—Under this heading our contemporary the *City Leader* on November 28th issued an article on the history of Mr. Emile Garcke of the Brush Company, Electric and General Investment Company, Chelsea Electricity Company, City of Bath Electric Light Company, and of the London Chamber of Commerce (Electrical Section).

Cheap Telephones.—*Industries* announces that a new system has been introduced by the Stockholm General Telephone Company. It is a cheap telephone, with an annual charge of 11s., and a charge for each telephonic message of 10 öre, or 1¾d., the conversations to be registered by an automatic appliance. The instruments are of the usual kind, and the new central office, which has recently been opened, has already 300 subscribers.

Postal Telegraphs in Spain.—Under the title of the *Department of Communications*, the postal and telegraph departments of Spain have recently been amalgamated.

Telephones in Spain.—Telephonic communication between Madrid and San Sebastian, a distance of almost 300 miles, is to be established.

Telegraphs in New Zealand.—During the year 1890, 1,916,161 telegrams were dealt with by the New Zealand telegraph department as against 1,802,987 in 1889, being an increase on the year of 158,174.

The Chronophotograph.—A very long and interesting article on the chronophotograph, appears in a recent number of the *Revue Générale des Sciences Pures et Appliques*, from the pen of M. E. J. Marey. By means of this instrument, it is possible to obtain photographs of successive movements in physical and natural science.

Electric Tramways v. Railways.—Owing to the excellent service of electric tramways between St. Paul and Minneapolis, in the United States, they are patronised in preference to the railways. So much has this been the case, that the railway companies have been working at a loss, and have recently been compelled to withdraw some of the trains from that line.

Telephones in the United States.—A company has recently been formed to establish telephonic communication between the chief towns of Fulton and Hamilton Counties, in the State of New York, U.S.A. The company is called the Sharer Telephone Company. The line will pass through Johnstown, Gloversville, Broadalbin, Mayfield, Northville, Wells and Sageville.

The Electric Light in France.—We learn from our contemporary, *Bulletin International de L'Electricite*, that a project has been prepared for the establishment of a central electric supply station in Carcassonne. The necessary power would be obtained from a waterfall in the district. A central station, in which Ferranti dynamos are used, has also just been completed at Nimes, in France.

Train Lighting in Switzerland.—From an interesting article on the electric lighting of trains on Swiss railways, in a recent number of our contemporary, *Schweizerische Bauzeitung*, we learn that the J. S. Railway has at present about 120 vehicles lighted by electricity. These include 50 passenger carriages of all classes, several luggage vans, and several waggons employed in the postal service, &c. The lamps are provided with current from a battery of accumulators of the Huber type, placed in each carriage.

Interruptions of Telegraphs.—The Eastern Telegraph Company, Limited, notifies that communication with Zanzibar and South Africa is interrupted by both the east and the west coast routes. Telegrams for places on the east coast of Africa and South Africa can only be accepted at the sender's risk. They will be forwarded by telegraph to their destination as soon as the communication is re-established by either route. It is expected that the west coast route will be restored by the end of next week.

Fluctuations in the Price of Copper.—It is interesting as well as startling to notice the enormous fluctuations which have taken place in the prices of copper within the last three months. Our esteemed contemporary, *Engineering*, published a plain and striking diagram, in last week's issue, which shows very clearly the respective prices of the metal at the beginning of September and the end of November. From this diagram we understand that on the opening market day in September copper was quoted at £53 per ton; about the middle of October it had fallen to £49 10s.; and during November the price had been gradually decreasing until on the last market day the price had fallen to about £45. It will thus be seen that the price on the closing day was £8 below that on the opening day of the three months referred to.

Plates for Secondary Batteries.—A solution is made by boiling litharge in a very concentrated solution of caustic soda and potash. A lead plate boiled in this solution will receive a coating of spongy lead ½-inch in thickness. This can be pressed down so as to occupy only one one-hundredth of an inch. A plate thus prepared yields readily to the forming process. The *Scientific American* says that this method is due to Edison.

The Molecular Conductivity of Acids.—The molecular conductivity of acids, in various solvents, is the subject of a short paper, by K. Hartwig, in the *Ann. Phys. Chem.*, Series 2, Vol. xliii., p. 839. The molecular conductivity and the temperature coefficient has been calculated by Hartwig in a number of typical cases, *e.g.*,

Formic acid	dissolved in	Methyl alcohol
Acetic „		Ethyl „
Butyric „		Amyl „
Oxalic „		

It was observed that when the solutions were gradually diluted, the molecular conductivity, as a rule, was gradually increased. But several exceptions were noticed: thus, when the molecular conductivity of formic acid in ethyl and methyl alcohol, and of oxalic acid in ethyl alcohol were plotted on curves, these curves showed well-defined maxima and minima. When the molecular conductivity is at a maximum, the temperature coefficient is at a minimum, and *vice versâ*. By this coefficient is meant, of course, the α in the formula

$$K_t = K_0 (1 + \alpha t + \beta t^2).$$

Errors in Electro-chemical Researches. — In the *Monatshefte*, Vol. ix., p. 903, Exner and Fuma showed that the results obtained by Ostwald in his electro-chemical investigations with dropping electrodes of mercury were untrustworthy, inasmuch as certain sources of error remain unnoticed, viz., the chemical action of the electrolyte upon the mercury and the subsequent occurrence of polarisation. These errors also occur in the observations of Moser and Miesler, and vitiate their results. In order to obtain more trustworthy observations, a method was devised and has recently been used by Exner for measuring the difference in potential between various metals, on the one hand, and aqueous solutions of the halogens and halogen acids of different concentration on the other. This method was essentially as follows:—The mercury was allowed to drop into a cylinder of filter paper, wetted with and connected by a damp thread to the solution in which dips the metal under examination; this plan avoids the two errors referred to above. Exner has drawn up his results in the form of tables and curves, which may be consulted in the *Monatshefte*, xii., p. 276.

Another New Process for Recovering Tin from Tin-plate, &c.—The use of electricity in recovering tin from waste tin-plate has been a feature in several recent proposals, the latest of which is by Mons. Berton. Sodium nitrate or potassium chlorate are used in conjunction with hydrochloric acid under conditions which appear to be particularly favourable to the dissolution of the tin. The nitrate or chlorate required for dissolving off the tin from a ton of scrap is first dissolved in about 110—220 gallons of water; the acid is then added and the solution then heated to a temperature between 30° and 50° Centigrade, according to the concentration of the liquids. It is now ready for the first batch of waste. The reagents are used in the proportions represented by the following chemical equations:—

In the case of the nitrate:

$$\underset{\text{Tin}}{4\,Sn} + \underset{\text{Hydrochloric acid}}{14\,HCl} + \underset{\text{Sodium nitrate}}{Na\,NO_3} = 4\,(Sn\,Cl_2, HCl) + 3\,H_2O + Na\,Cl + NH_4Cl.$$

In the case of the chlorate:

$$\underset{\text{Tin}}{3\,Sn} + \underset{\text{Hydrochloric acid}}{9\,HCl} + \underset{\text{Potassium chlorate}}{KClO_3} = 3\,(Sn\,Cl_2, HCl) + KCl + 3\,H_2O.$$

When the first batch of waste is completely stripped, the residual iron is removed, more waste introduced and then heated at a higher temperature. Finally when the mixed solutions have become "spent" or "killed" or exhausted, the metallic tin is separated out from them by the method of electrolysis.

Crystal Palace Electrical Exhibition.—In a leading article regarding this exhibition, our contemporary, the *Contract Journal*, states that borough surveyors will be able to collect materials and data at the Crystal Palace which will save them an immensity of trouble in answering questions or preparing reports on the subject. The general public, too, will perforce be educated up to a better comprehension of the advantages of what is (questions of cost being omitted) the light *par excellence*, either for public or private use.

The German Post-Master's Report.—From the official report published by Dr. von Stephan recently, it appears that in all branches of the German post and telegraph administration, a great development has taken place during the period, 1888—90, treated in the report. In the case of telephony, it is said that no European country approaches Germany for the number of public call offices. There were only 25,829 of these in 1888, whilst at the end of 1890 there were 52,405. At the end of March last there were no less than 15,060 in Berlin alone, this being a number which is not surpassed by any other city in the world. The posts and telegraphs receipts for the period between the commencement of the budget year and the end of October, were 133,524,557 marks, or an increase of 5,387,702 marks as compared with the corresponding period of last year.

Leather used in Belts.—The magnitude and importance of the Electric Power Station of the West End Street Railway Company of Boston may be somewhat estimated from the following description of the belts used, taken from the *Boston Weekly Transcript*:—"The largest leather belts ever made in New England are those manufactured for the power station of the West End Street Railway Company on Albany Street. Their approximate breaking strain is 64,800 pounds. Twelve of the belts are each about 150 feet long and 54 inches wide. It required 1,980 hides, or 79,200 pounds of leather, for their manufacture. Two of these belts are to be used on each flywheel, giving a belt surface of 108 inches, which is supposed to be the largest belt surface ever used on a single flywheel. The order also includes 24 belts 30 inches in width to run the generators. These are also made double, and of the same high quality of stock. This will consume 625 hides, or 27,000 pounds of leather. The whole order will require over 2,600 hides, or about 104,200 pounds of leather.

Alum Solution.—A letter appeared in our contemporary, *Nature*, very recently, from a correspondent, in which he gives evidence of the *practical* superiority of potash alum solution to distilled water in adiathermancy, *when the electric arc is the radiant* and the "radiometer" a Crookes, which he thinks will be of interest. The same glass-sided cell was used throughout, and the difference of voltage between the carbons ("Apostle") was kept sensibly constant (40 volts) through the experiments. Between each observation on the liquids the radiation from the arc was observed, unimpeded, save by the glass of the radiometer, as recorded below. The time was given by a metronome (previously examined for constancy) beating half-seconds. No lens was used.

	No. of revolutions of radiometer arms.	Time in Half-seconds.
1. Unimpeded radiation	25	160
2. Through empty cell	25	254
3. Unimpeded radiation	25	152
4. Cell + water	25	820
5. Unimpeded radiation	25	164
6. Cell + water (second experiment)	25	832
7. Unimpeded radiation	25	160
8. Cell + alum solution	25 (time of two revolutions actually taken.)	43,200
9. Unimpeded radiation	25	160

The current throughout was 6·4 amperes, thickness of each glass plate 1·5 mm., thickness of solution 50 mm., distance of radiometer from arc 1 metre.

Volk's Electric Railway.—The damage done to the electric lines at Brighton in the recent gale has been thoroughly restored, and everything is in working order again. The cars resumed running last Friday.

Central Stations.—*Electrical Plant* will publish, on January 1st, a special central station lighting number. It will be devoted entirely to the illustration and description of central stations at home and abroad. It is intended to be a permanent record of electric lighting progress up to date.

The Great Northern Railway and the Electric Light.—The Great Northern Railway Company are about to extend the use of the electric light on their system. The terminus at Amiens Street, Dublin, has now been provided with two Brush arc lamps of 2,000 candle-power each, and an Edison-Swan 200 candle lamp has been placed in the booking-office hall. The experiment of trying the lamps came off last Friday evening, and proved so successful, that the company intend to light the terminus with eight arc lamps, four on each platform. The necessary machinery has been supplied by the Electrical Engineering Company of Ireland.

Krasnapolsky Winter Garden. — This beautifully decorated building, situated at 32, Oxford Street, has been lighted throughout by electricity. Upwards of 1,500 incandescent lamps and four arc lamps are fixed. The generating plant consists of three compound engines of 80 I.H.P. each, by Ruston, Proctor & Co., of Lincoln, driving three Crompton compound-wound dynamos, each capable of supplying 380 amperes at 110 volts. Steam is supplied from two 30 H.P. and two 20 H.P. locomotive boilers, working at 100 lbs. pressure. The whole installation has been carried out under the direction of Mr. G. E. Hartmans, consulting engineer.

A Method of Repairing Damaged Filaments.—A method of repairing broken filaments economically has been discovered by a French engineer. A hole is made in the bulb and the broken filament taken out, excepting a small piece which is left attached to the platinum supports. The bulb is now filled with some liquid hydrocarbon, and a new filament is placed within it, in such a position that its ends just touch the remaining ends of the old filament. An electric current is now passed through the lamp; this has the effect of decomposing the hydrocarbon, liberating hydrogen gas, whilst solid carbon is deposited at the free ends of the filament in such a way that the old and the new portions are cemented together. Finally, the bulb is cleaned, exhausted of air and the hole sealed up.

Fathers of Electrical Science.—The *Scientific American* states that at a meeting of the Committee on Electricity, Electrical and Pneumatic Appliances, of the World's Columbian Exposition, the following names were decided upon as those of eminent electricians, not now living, to be placed over the electricity building at the exposition, namely: Franklin, Page, Joule, Galvani, Weber, Saussure, Ampère, Gilbert, Cooke, Faraday, Davenport, Varley, Ohm, Sœmmering, Steinheil, Sturgeon, Don Silva, Guericke, Morse, Arago, Laplace, Siemens, Daniell, Channing, Davy, Jacobi, Priestley, Volta, Wheatstone, Maxwell, Henry, Gauss, Coxe, Oersted, Vail, Thales, Coulomb, Bain, Cavendish, Ronald, De la Rive.

Lightning Conductors.—Dr. Hess, who has been collecting statistics and has examined the tips of many lightning rods, finds, says the *Scientific American*, that fusion of the points never occurs. A fine smooth point receives the lightning in a concentrated form, while angled or ribbed, as well as blunt points, divide it into threads. Dr. Hess considers that platinum needles and tips are entirely unnecessary, for they have no advantage over copper points; but as there are lightning strokes which are capable of making wire 0·20 inch thick incandescent, unbranched copper conductors should never be of less diameter than this, though in a good lightning rod the main point is to secure perfect communication between it and the earth.

Electric Light in Hatton Garden.—At the meeting of the Commissioners of Sewers last week, an application from the Metropolitan Electric Supply Company for permission to lay down a main along the north side of Holborn for the purpose of lighting Hatton Garden was referred to. The Streets Committee recommended that the company should be informed that the commissioners had no authority to grant such permission to any company not possessing Parliamentary powers for the purpose. This was adopted.

Electric Lighting at Cowes.—The special lighting committee at the last meeting of the Cowes local board reported that with respect to the application of the Isle of Wight Electric Lighting Company to the Board of Trade for a license to light Cowes by electricity, they were of opinion that it would be of benefit to the town if the license were granted, provided certain provisions were inserted as to the price, and it would recommend that one of the promoters should be interviewed, and the whole scheme then submitted to an expert in order to safeguard the interests of the town. After some discussion the report was adopted.

Magnetic Reluctance.—The report of the discussion on Mr. Kennelly's paper, which we referred to on page 579, is now to hand. The discussion rather drifted from the point towards the end, and landed on the question of the ubiquitous 4π, which is now so much exercising people's minds. One speaker was inclined to lay its presence to the door of providence rather than to what Mr. Heaviside calls "irrational units." It would doubtless be simpler to get rid of the multiplier from our magnetic equations, but this would be bought at too dear a price if we had to alter all our standards of resistance, &c. In theoretical investigations the advantage is with Heaviside's views, in spite of the sneer which one of our contemporaries makes at that writer when it designates him "a pedant with a notion."

Rate of Propagation of Induced Magnetism in Iron.—Mr. Trouton has recently published some rather interesting experimental work undertaken with a view of ascertaining the time rate of propagation of magnetism round a magnetic circuit. Although he got no results bearing on the point at issue, he succeeded in establishing a peculiar species of stationary magnetic vibrations in a ring of iron wire by means of an alternating magneto-motive force applied at one point. The vibration consists in a series of nodes and internodes in the half of the ring opposite to the place at which the current is applied. These are apparently due in some way to the interference of the waves of magnetism going away both sides from the coil, but, unfortunately, they are not of the nature Mr. Trouton was looking for. The subject seems well worthy of further investigation.

Gas v. Steam Engines for Electric Lighting Stations.—Our contemporary *Electrical Plant*, in a leading article under the above heading, states that for small stations it has no doubt that the gas engine would be vastly more economical than the steam engine. Prof. Kennedy recently gave it as his opinion that the best unit for a central station should not exceed 200 H.P., for the reason that with engines of larger power it was extremely difficult to keep them fully loaded, while the efficiency of a steam engine of 2,000 H.P. is but little better than one of 200 H.P. Our contemporary further says that in foggy weather it is absolutely necessary to be prepared at a central station to double or treble the output of current at a few minutes' notice, but this can only be done by keeping steam up in several reserve boilers, and although the few engines which are fully loaded may be worked very economically, yet the average consumption of coal per H.P. per hour is high, reaching probably 10 lbs. for direct current plant with storage batteries, and 20 lbs. to 25 lbs. for alternating plant. It seems well worth consideration as to whether it would not be better to instal Dowson gas plant and gas engines, up to say 100 H.P. instead of steam engines and boilers. There is no doubt that a large saving in working expenses would be realised for small central stations in the country, and country mansions, if our contemporary's suggestion was adopted.

Overhead Wires in Australia.—The danger of overhead telegraph and telephone wires has been brought before the Victorian Government, and the Postmaster-General has arranged with the city council of Melbourne for all the wires to be laid underground. This change will cost nearly £80,000.

Interruption of Telegraphic Service.—The Eastern Extension, Australasia, and China Telegraph Company notifies the interruption of the Hongkong-Manilla cable. Until its restoration telegrams will be sent by post by every available opportunity. A mail boat is expected to leave Amoy early next week. Telegrams to catch this vessel should be despatched at once.

A Sign of the Times.—At a meeting, on the 15th inst., of the Society of Gas and Water Technicians for Rhineland and Westphalia, it was resolved to supplement the title of the institution by adding after the word "gas" that of "electrical," &c. Subsequently a paper describing the Düsseldorf central station and gas works was read, and in future electricity will occupy a prominent position of the proceedings of the society.

Provisional Order, Bury St. Edmunds.—At the December meeting of the Bury St. Edmunds Town Council, it was stated that the provisional order obtained by the council in 1882 for electric lighting has expired, and it was resolved that application should be made to the Board of Trade for its renewal. Mr. Gough was of opinion that they should begin generating a little electric light, in order to maintain the rights they had obtained.

The Telephone in Austria.—A Reuter's telegram, dated Vienna, December 3rd, says:—The Marquis von Bacquehem, Minister of Commerce, to day announced in the Lower House of the Austrian Diet that telephonic communication would shortly be established between Vienna and Trieste. Referring to the reduced telegraph rates which come into force on January 1st next, the Minister said that this reduction would be of great benefit to trade, and expressed the opinion that the loss arising from the reduction would be compensated for by the increase in the number of telegrams.

The Electric Lighting at the Mansion House.—A meeting of the Court of Common Council was held last week, at Guildhall, the Lord Mayor presiding. Mr. G. E. Wood, chairman of the General Purposes Committee said the Planet Electric Lighting Company were making very satisfactory progress with the installation of the electric light at the Mansion House, and it would be completed and in operation at the end of this week. The supply of electricity to the Mansion House would not be affected if delay arose in the completing of the contracts for the public lighting of the City.

Electric Lighting Dangers.—A German paper has the following:—The dangers attendant on electric lighting have been shown lately in Berlin. An electric cable and telegraph cable repeatedly cross one another. In such places the telegraph cable is laid in an iron pipe which for the sake of extra protection is made 1½ cm. thicker. In one place in the lighting cable which had become damaged, the electric current in the lighting main melted its own cable, and also the iron protecting tube of the telegraph cable. The molten liquid finally succeeded in destroying the telegraph cable which could no longer be kept in use.

O. S. A.—The first smoking concert of the new session on the 4th inst., was a most enjoyable one. The attendance was large, the programme good and the performances above the average. Professionals and amateurs were equally well appreciated, to judge by the applause and encores after popular pieces. Thirty new members and associates were elected at the last meeting. An ordinary general meeting will be held at the Finsbury Technical College on Wednesday, December 16th, at 8 p.m., when a paper will be read by Mr. Rollo Appleyard, entitled "The Measurement of the resistance of conductors containing disturbing electromotive forces, with special reference to earth plates." The subject is an important one and old students and their friends are requested to come in full force.

The Royal Society.—The following paper was announced to be read yesterday before the Royal Society:—G. T. Walker, "Repulsion and Rotation produced by Alternating Electric Currents."

Royal Institution.—The following are amongst the lecture arrangements before Easter:—Prof. J. A. Fleming, three lectures on "The Induction Coil and Transformer," and the Right Hon. Lord Rayleigh, six lectures on "Matter: at Rest and in Motion." The Friday evening meetings will begin on January 22nd, when a discourse will be given by the Right Hon. Lord Rayleigh on "The Composition of Water." Succeeding discourses will probably be given by Sir David Salomons, Bart., Prof. Oliver Lodge, Prof. W. E. Ayrton, and other gentlemen.

Minimum Diameter of Conductors.—The American Electric Lighting Association has published a table of conductors, the diameters of which correspond to the maximum numberof ampères which the circuits can carry with safety:—

B.W.G.	Ampères.	B.W.G.	Ampères.
0000	175	6	50
000	150	7	45
00	130	8	35
0	110	9	30
1	95	10	20
2	85	12	15
3	75	14	10
4	65	16	5
5	60	...	...

If *not* insulated, the diameter of the wire for a given current must be *increased* 40 per cent.

The Gas Supply of London.—Yesterday's *Times* states that the Board of Trade has undertaken to appoint a committee to consider what the standard of light for testing the gas supply of London should be, the present candle standard having been found to be very untrustworthy. The appointment of the committee, which will be composed of scientific men, has been delayed because the Board of Trade and the London County Council have no fund available for paying the expense of a committee, while the London gas companies refused to undertake the cost. The South Metropolitan Gas Company, of which Mr. G. Livesey is chairman, have now undertaken to pay the whole of the expenses, and the committee will very shortly be formed. It will consist of two members nominated by the County Council, one by the City Corporation, three by the London gas companies, together with the three Gas Referees, and two independent scientific men. Dr. E. Frankland, F.R.S., and Mr. Dibdin, the council's chemist, will represent the London County Council. Pending the report of this committee, the council has deferred action in the direction of obtaining legislation for a more exact standard of light.

Triphased Alternating Currents.—We sent a proof of Prof. Ayrton's letter (see correspondence columns) to the author of the articles which have recently appeared in the REVIEW on the subject of "Polyphased Alternating Currents." His reply is given below:—"The difference between the two modes of winding in Mr. Brown's dynamo, one of which was shown in the ELECTRICAL REVIEW for October 23rd, and the other by Prof. Ayrton, in the last number of *Nature*, is only an apparent difference. In our diagram, as in Prof. Ayrton's, the winding of each circuit comprises 32 wires, connected together in a zig-zag fashion, and the space between two consecutive wires in the same winding is occupied by a wire belonging to each of two others. All we have to do in either case is to connect suitably the free extremities of these three circuits, in order to obtain three currents with a lag, not of 120°, as Prof. Ayrton says, but of a third of a period, which is a very different thing. If, in the winding we have shown, we put the letter *b* in the place of the letter *c*, and *vice versâ*, we arrive exactly at the accompanying figure. It is therefore not correct to say that a dynamo wound, as shown in our figure, could not produce three alternate currents with a lag of 120° (a third of a period).—E. H."

Electrical Journalism.—A new Electrical Journal will be published in Paris at the beginning of next year, entitled *L'Industrie Electrique*, with M. E. Hospitalier as editor-in-chief.

New Telephone Service.—A telephonic service will, says the *Financial News*, be established next spring between Athens and the Piræus, and the necessary apparatus has already been ordered. The yearly subscription will be 200f. in Athens and 175f. in the Piræus.

Telephone Licences.—Mr. A. Erskine Muirhead, managing director of the Caledonian Telephone Company, Limited, has been informed by the Post Office that they are now prepared to receive the company's application for a license, and will then indicate the terms upon which it will be granted. It would seem that the telephone monopoly, so far as exchange business is concerned in Scotland, is drawing to a close.

Electric Light at Nottingham.—The Nottingham Town Council, on Monday last, empowered a special committee to spend £25,000 to £30,000 in lighting a central section of the borough by electricity. In the course of the discussion Alderman Sir John Turney explained that at present the scheme did not involve an outlay of more than £30,000, but if, after that money had been spent, the council thought well to sanction an expenditure of £50,000 to £100,000 that would not be the fault of the Electric Lighting Committee, but would rest with the council itself.

Hastings Electric Lighting.—It is stated that at the meeting of this council last week with reference to the proposal made at the previous meeting to substitute gas for the electric light on the front line, the Public Lighting Committee reported that the electric light company could not make any reduction in the amount of the contract, but that if the committee were prepared to extend the electric lighting, and to adopt all-night lighting, they would be happy to reconsider the whole matter. The committee recommended that the contract be renewed for another year from November 26th.

Electrocution.—Telegrams from Sing Sing, New York, to the *Morning Advertiser*, on the 7th inst., state that a number of witnesses and experts had arrived there to witness the execution by electricity of the wife murderer, Martin D. Loppy. The crowd in waiting could hear the noise of the machinery which runs the dynamo for some time before Loppy was put to death. After the rumbling had continued for some minutes the prison signal was run up the flagstaff, and the machinery stopped. The crowd was mainly composed of journalists waiting to interview eye-witnesses of the scene.

Electric Lighting of Rhondda Valley.—A large and influential meeting was held on Wednesday, last week, for the purpose of taking into consideration the question of the supply of the district from Treorchy Hotel down to Gelligaled with electric light. Explanation of the system of electric lighting was given by several practical gentlemen, and it was unanimously resolved that steps be taken immediately with the view of securing a supply by means of a public company. A large and representative committee was appointed, and it was decided to thoroughly canvass the whole district, and have the result submitted to another meeting.

Swansea-Mumbles Railway.—A correspondent writes: "I hear, on what appears to be authentic authority, that the present steam tramway between Swansea and Mumbles, a distance of about five miles, is to be worked by electricity. The traffic over this line is very heavy during the summer months, it being no unusual thing for from 20,000 to 30,000 passengers to travel between the two termini. There are 10 stations *en route*, at all of which a stoppage is made. A maximum speed of about 10 miles an hour is all that is asked for, and in face of this comparatively low speed, it is stated that the cost of electric locomotion will be less than that of the present system."

Pontypridd and the Electric Light.—The authorities at Pontypridd, an important town right in the centre of the Welsh coal field, will, it is stated, at an early date, consider the advisability of introducing the electric light in lieu of gas.

Working of Indian Telegraphs.—A recently issued report of the Administration Department states that the additions to the system have consisted of 1,791 miles of line, 7,373 miles of wire, and 21 miles of cable; 118 new offices have been opened during the year.

Swansea and Electric Lighting.—It is a generally accredited fact that the Swansea Town Council purposes to follow in the footsteps of Cardiff in regard to the adoption of the electric light as an illuminant in the principal parts of the town. The matter has already received some attention in the local press, and it is stated that the subject will be introduced at an early meeting of the council.

Electric Lighting at Manchester.—At the last meeting of the Manchester Council it was stated that, owing to the Paving Committee consenting to give up possession of their land in Dickinson Street to the Waterworks and Gas Committees within a period of six months from that date, the work of preparing for the introduction of the electric light could be proceeded with without the least delay. It was also stated that no time would be lost in putting down the necessary fittings for the electric light installation in the Town Hall.

The Telephone in London.—A letter appeared in the *Times* of Tuesday last from Mr. A. A. Campbell Swinton. He relates a recent personal experience of the methods of the National Telephone Company in London. He states that on the morning of Friday, November 13th, the telephone in his office was found to be totally inoperative. Though notice was at once given, and several times repeated, the company neglected to complete the necessary repairs until the following Wednesday, with the result that the office was entirely cut off from telephonic communication for six days. By such a method the National Telephone Company not only put their subscribers to a vast amount of inconvenience but, in addition, contrive to receive payment for telephonic facilities over periods during which they have not provided any facilities at all.

Private House Lighting in Ireland.—The electric light as a means of lighting private houses appears to be making headway in Ireland. We learn that the residence of the well-known brewer, Mr. J. J. Murphy, on the banks of the Lee, is being lighted throughout on the incandescent system. The house and out-offices are being wired for about 100 lamps in all. A Robey engine is being put down to drive a 6-unit dynamo of the Elwell-Parker type. A set of accumulators will also be used, so that the lights can be run when the engine is not working. Costly electroliers are in course of preparation for the reception rooms to correspond with the general decorative appearance of the house. The entire installation is being carried out to specification by Messrs. J. K. Fahie & Son, electrical engineers, of Dublin.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric Welding Company, Limited.—The following was filed on the 2nd inst.:—In the High Court of Justice, Chancery Division, Mr. Justice Romer for Mr. Justice Sterling, at Chambers, Monday, November 23rd, 1891. In the matter of the Companies Act, 1862, and in the matter of the Electric Welding Company, Limited, upon the application by originating summons dated October 8th, 1891, of Thorndike Nourse, of 2, Austin Friars, in the City of London, financial agent, and upon hearing the solicitors for the applicant and for the above-named company, and upon reading the affidavit of the said Thorndike Nourse, filed October 23rd, 1891, and the exhibit therein referred to, and the affidavit of Arthur John Davis, filed November 23rd, 1891, and by consent. It is ordered that the register of shareholders of the said Electric Welding Company, Limited, be

hereby rectified by removing therefrom the name of the said Thorndike Nourse as the holder of one founder's share and 49 ordinary shares in the said company, and it is ordered that notice of this order be given to the Registrar of Joint Stock Companies by leaving a copy thereof with him; and it is ordered that the said Electric Welding Company, Limited, pay to the said Thorndike Nourse the sum of £11 17s. 8d., being his ascertained costs of this application. Registered office of the company, 6, Great George Street, Westminster, S.W.

General Electric Company, Limited.—The annual return of this company, made up to the 30th ult., was filed on the 1st inst. The nominal capital is £60,000 divided into 7,000 1st preference, 1,000 2nd preference, and 4,000 ordinary shares of £5 each; 11,325 shares have been taken up, and upon 6,325 the full amount has been called and paid, the ordinary and 2nd preference shares having been issued as fully paid. Registered office, 71, Queen Victoria Street, E.C.

Bicester Electricity Supply Company, Limited.—The first registered office of this company is situate at Market Hill, Bicester, Oxfordshire.

Isle of Wight Electric Lighting Company, Limited.—The first registered office of this company is situate at 21, Lime Street, London, E.C.

BUSINESS NOTICES, &c.

The Phosphor Bronze Company, Limited.—The Phosphor Bronze Company announce that they have acquired the sole license for the manufacture of *Bull's metals*, which they now supply in the form of ingots, billets, castings, forgings, stampings, rolled rods and sheets. The extraordinary malleability, tensile strength and durability of these alloys render them specially adapted for the wants of engineers, shipbuilders and others requiring a strong non-corrosive metal of high quality at a moderate price. The inventor and patentee, Mr. John C. Bull, has joined the company as consulting engineer, and will superintend the manufacture of his alloys at our various works.

A recent issue of *The Manufacturer and Inventor* contains a very full account of the history of this company. The description is profusely illustrated, and photographs appear of the interior and exterior views of the foundry in London and the works at Birmingham; there are also photographs of a "phosphor bronze" torpedo boat and of the company's four wire shops, two casting shops, cartridge-metal and bolt mills, and rolling mills. We also notice photographs of the general manager of the company, Mr. R. Lagerwall, and the Birmingham district manager, Mr. W. A. Perry, M.I.M.E. From the very interesting information given, it seems that the company appears to have gathered around it a thoroughly competent and appreciative staff of workmen, who know full well that merit and good work will always command recognition from their senior officers.

Woodhouse and Rawson.—A Johannesburg contemporary just to hand states that Mr. Lewis Cousens, representing Woodhouse and Rawson, at Barberton, has arranged with Moodie's Company for the supply of a large electrical transmission plant for the purpose of supplying all their companies with power.

We learn from a Johannesburg contemporary just to hand, that the Gas Works Company, after repeated delays, have decided to, at once, make a beginning by having 9 electric lamps of 2,000 nominal C.P. each, erected in the chief thoroughfares of the town of Johannesburg. The contract is in the hands of Messrs. Woodhouse and Rawson, the dynamos and lamps being of the Brush type. It is not unlikely that the gas company will ere long proceed to have six more lamps erected.

Woodside Electric Company.—We have received from the Woodside Electric Company, of Glasgow, a copy of their revised price list of Woodside High C.P. High Efficiency Incandescent Lamps. These lamps are of 2 watts per C.P. efficiency, and are eminently suited for lighting shops, warehouses and cargo hatches on board ship, and for almost any position indoors requiring a brilliant, steady, reliable light, without trouble, attention or inconvenience of any kind. They can be fitted much cheaper and run quite as economically as arc lamps. The three advantages claimed for the Woodside as compared with small incandescent lamps are: 1. Great saving in initial cost. 2. Immense reduction in running and renewal expenses. 3. A white and more brilliant light.

Waller and Manville.—We understand from an article appearing in the *Freeman's Journal*, that the President and Council of the Royal College of Surgeons at Dublin have decided to re-construct the chemical laboratory and to erect pathological and bacteriological workrooms, and to have the whole of these schools, together with the college itself, lighted electrically. They have accordingly retained Messrs. Waller and Manville, of 39, Victoria Street, London, to advise them on the matter and supervise the work. The tender of the Electrical Engineering Corporation of Ireland, Limited, was accepted by the Council.

Tender Wanted, Tiverton.—As we have previously announced in our "Notes" columns, the Tiverton Town Council invite offers from persons or companies for the transfer for a term of years of their powers under the Tiverton Electric Lighting Order, 1890. We now have pleasure in stating that the provisional order and a plan of the areas of supply may be seen by appointment at the office of Mr. J. Siddals, Borough Engineer, Town Hall, Tiverton. Tenders and full particulars to be deposited with the Town Clerk (Mr. C. Marshall Hole), by January 1st, 1892.

W. Sargeant & Co.—Mr. W. S. Sargeant, Electric and Steam Launch Builder, Strand-on-the-Green, Chiswick, has been successful in gaining the £25 prize as offered by the Paignton Promenade Pier and Torquay Ferry Company for the best designs and drawings for the electric launches plying between Paignton and Torquay; also a 65-feet steam launch to carry 100 passengers for the proposed trip round Torbay. These vessels are to be built in the best possible manner and to the Board of Trade's requirements, and to be delivered at Torquay on May 1st, 1892.

J. G. Statter & Co.—We have received from Messrs. Statter & Co. a copy of their revised illustrated catalogues of dynamos, motors, and other electrical plant for transmission of power and for central stations. The firm have also issued a descriptive pamphlet of the plant recently supplied by them. It will be remembered that Messrs. Statter purchased the patterns, drawings, and selected stock of the Electrical Engineering Corporation, Limited.

Tender Wanted, Birmingham.—The chairman of the Baths Committee invites tenders for the complete electric lighting installation of the baths for the Aston Manor Local Board. Further particulars obtainable on application to Mr. W. Augustus Davies, A.M.I.C.E., engineer to the Board, Public Offices, Aston Manor. Latest date for acceptance of tenders, December 21st.

Latimer Clark, Muirhead & Company, Limited.—At a meeting of the Richmond Town Council held on the 8th instant, it was decided by a large majority to seal a contract with Messrs. Latimer Clark, Muirhead & Company, Limited, electrical engineers, Westminster, for the electric lighting of Richmond, Surrey, for a period of 30 years.

University College, Nottingham.—The committee are inviting application, for the post of demonstrator in electrical engineering at University College, Nottingham. Remuneration £150. Applications for the post must be sent to the secretary on or before December 16th.

CITY NOTES.

The Eastern Telegraph Company, Limited.—This company announce the payment on January 14th next, of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the preference shares of the company, for the quarter ending December 31st; and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended September 30th. The transfer books of the company will be closed from January 7th to 14th, both days inclusive.

The Sheffield Telephone Exchange and Electric Light Company, Limited.—The *London Gazette* announces that a general meeting of the members of the above-named company will be held at the registered offices, Commercial Street, Sheffield, on January 14th, 1892, for the purpose of receiving from the liquidators an account showing the manner in which the winding up has been conducted, and the property of the company disposed of, and of hearing any explanation that may be given by the liquidators.

The Commercial Cable Company.—This company officially announce the payment on January 2nd, 1892, of the usual quarterly dividend at the rate of 7 per cent. per annum. It is further announced that the drawing of bonds to take place this month for repayment in January will again be at the maximum of £120,000. The outstanding bonds will thereby be reduced to £200,000.

The National Telephone Company, Limited.—Interim dividends at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the ordinary, have been declared by the directors of the National Telephone Company, Limited.

Chili Telephone Company, Limited.—The Stock Exchange Committee have appointed 10th inst. a special settling day in the Chili Telephone Company shares Nos. 1 to 40,000. They have also ordered this company's securities to be quoted in the Official List.

Western Union Telegraph Company.—This company has declared a quarterly dividend of 1¼ per cent.

TRAFFIC RECEIPTS.

The City and South London Railway Company. Traffic receipts for the week ending December 6th, amounted to £810.

The Great Northern Telegraph Company. Receipts in November, 1891, £22,400; 1st January to 30th November, 1891, £260,200; corresponding months 1890, £256,400; corresponding months 1889, £259,400.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Dec. 3rd.)	Closing Quotation. (Dec. 10th.)	Business done during week ending (Dec. 10th, 1891.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	49 — 50	49½— 50½	50	49½
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87 — 88	87½— 88½	88⅝	87½
2,849,510*l*	Do. do. Deferred	Stock	12 — 12¼	12⅝— 13⅛	13⅛	12⅛
130,000*l*	Brazilian Submarine Telegraph, Limited	10	11 — 11½	11 — 11½	11⅜	11⅛
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3½	3½— 3⅝	3⅝	3½
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2¼	2⅛
40,000*l*	Chili Telephone, Limited, Nos. 1 to 40,000	5	... — ...	4 — 5	4	...
50,000*l*	City and South London Railway, Nos. 1 to 50,000	10	3 — 5	3 — 5	3½	...
30,152*l*	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	6	4½— 5½	5 — 6	5½	5
$7,716,000	Commercial Cable, Capital Stock	$100	145 —148	145 —148	150	144½
224,850*l*	Consolidated Telephone Construction and Maintenance, Limited ..	1/-	⅜— ½	⅜— ½	...	...
20,000*l*	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5¼— 5⅝	5¼— 5⅝	5⅝	5 7/16
16,000*l*	Cuba Telegraph, Limited	10	10 — 11	10 — 11	10⅝	...
6,000*l*	Do. do. 10 p. c. Preference	10	16 — 17	16 — 17	...	...
12,931*l*	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 3⅝	3½— 3⅝	3⅝	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9½— 10½	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅞— 11	10⅞— 11⅛	11	10⅞
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14¼	14 — 14¼	14¼	14
70,000	Do. 6 p. c. Preference	10	14⅝— 15¼	14⅝— 15¼	15	14¼
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	108	107½
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15 3/16	15
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	106	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	107 —110	107 —110	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	100⅞	100½
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	98 —101	99 —102	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6½— 7	6 — 7	6½	5½
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2 — 2¼	1⅞— 2⅛	2¼	2
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3¼— 3½	2⅞— 3⅛	3 5/16	2 13/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd	2	2⅛— 2⅛	2 — 2⅛	2 5/16	2
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— 9⅞	9⅝— 10	9⅞	9⅝
180,042	Do. do. 6 p. c. Preference	10	14½— 15	14½— 15	15	14½
150,000	Great Northern Tel. Company of Copenhagen	10	18⅜— 19½	18⅜— 19½	...	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	20½— 21½	20½— 21⅜	21½	20½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	104⅝	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	5 — 6	5 — 6	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8⅝— 9¼	8⅝— 9¼	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	106	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9⅜— 10¼	9⅜— 10¼	...	...
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝	4⅝	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13	12½— 13	12¾	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 13	12 — 13	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	107 —109	107 —109	108½	108½
250,000*l*	Do. (issued at 5 p.m., all paid)	25	28— 32	28 — 32	30½	...
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	6 — 7	6½— 7½	...	...
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16— 5/16	...	...
9,000*l*	Reuter's Limited	8	7½— 8¼	7½— 8¼	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¾— 9¼	8½— 9½	8⅞	...
7,900	Do. do. do. 7 per cent. pref.	2	7 — 7⅛	7¼— 7⅜	7⅜	7⅛
3,381	Submarine Cables Trust	Cert.	117 —122	115 —120	117	115½
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4 — 4⅛xd	4¼— 4⅜	4 7/16	4¼
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43¼	42⅜
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7½— 8½	7½— 8½	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	97 —100	97 —100	99	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3½— 4½	4	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 — 102	99 —104	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10 — 10½xd	10½— 10⅝	10⅝	10½
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 6⅝xd	6½— 6⅝	...	...
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	3⅞— 4¼	4 — 4⅛	4¼	4 1/16
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝xd	1½— 1⅝	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9 — 9¼xd	8⅞— 9¼	9¼	9
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	7½— 8¼xd	7 — 8	7½	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼— 6⅝	6½— 6⅝	6 7/16	6⅜

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅜.—Electric and General Investment, Shares of £5, £1 paid, 2⅜—3¼.—European Sims-Edison Torpedo Company, shares of £20, fully paid, 20—20½.—Halifax and Bermuda Cable, 4½ per cent. bonds, 85—95.—House to House Company (£5 paid) 4½—5.—*Liverpool Electric Supply, Shares of £5, £3 paid, 2⅜—2⅝. Shares of £5 (fully paid), 4⅞—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅜—1⅝. Do. 6 per cent. Preference, 1⅞—2¼.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅜—⅝.—National Telephone Debentures, 2½—3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2⅛—2⅜.—£5 Preference, fully paid 3⅛—3⅞.—Wards Electric Car, £10 paid, ⅜—1.

* Quotations on Liverpool Stock Exchange.

BANK RATE OF DISCOUNT.—3½ per cent. (December 10th, 1891).

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, CARDIFF, 1891.

REPORT OF COMMITTEE ON THE PHENOMENA ACCOMPANYING THE DISCHARGE OF ELECTRICITY FROM POINTS.

Section A.

PROF. LODGE, in bringing the report to the notice of the section, said it was a formal one and gave a very inadequate notion of what had been going on. He happened to know about this research, because it began in connection with experiments he had made in the discharge of electricity into the air on a large scale. Some members might remember that it was discovered in 1851 that when electricity was discharged from points into smoke or dust, that smoke or dust accumulated in particles on the points. Moist globules of fog or cloud, if they had some electricity discharged in their neighbourhood, fell into lines of force like iron filings. It was hoped that fogs might be cleared off by that method—not town fogs, because that was not the way to attack town fogs. The way to do that was not to produce them. But the fogs of the Atlantic, or those that hovered over the port of Liverpool, legitimate fogs, which interfered with the traffic, and by reason of which ships were sunk, these he thought it would be cheaper to cure by having very large machines (Wimshurst machines, he supposed), or some high E.M.F. dynamos, and expend a good many horse-powers in electrifying the air. A good many preliminary experiments would be required to know how much electricity could be got off from points, and he therefore requested Mr. Chattock to undertake experiments in this direction. They began with any number of needle points stuck along rods, and suspended in the lecture theatre at Liverpool; but the points would not appreciably discharge. Mr. Chattock found that a point did not discharge electricity so quickly as he (Prof. Lodge) had supposed, unless an opposite surface is brought near it. When there was a Brush discharge, electricity went away quickly from the point. When there was a simple glow on the point (St. Elmo's fire), the discharge was exceedingly small. Hence it was not so easy to get electricity out of the atmosphere as he at one time thought. So far as he knew, very little had been done in this direction; perhaps more had been done than he knew, but not so much as in other departments of electricity. Not much was known as to how the potential varied, and how the pressure of the air varied at different parts of the point; what the mechanical force on the point was. All these things Mr. Chattock had attacked and experimented on, and the results obtained seemed to him to be leading to very interesting conclusions. The report might be taken as an interim report, but Mr. Chattock's communication would give some notion of the form of the experiments. They understood from the report that, on the whole, it was coming out that the charge on the ions—that the thing was conveyed electrically.

ON THE ELECTRIFICATION OF STEEL NEEDLE-POINTS IN AIR, BY A. P. CHATTOCK.

Section 1.—As Faraday long ago put it, the discharge of electricity from a point into a gas may be looked upon as a particular case of sparking between a conductor, the point, and a non-conductor, the surrounding gas. It is, moreover, a particular interesting form of discharge, as compared with that taking place between two conductors, from the fact that it seems more likely to throw light on the unsymmetrical behaviour of positive and negative electricity. For there is evidence which points to the surface of the electrode as the origin of that want of symmetry; and, by experimenting with one electrode only, one is able, to a certain extent, to separate its effect on positive electricity from that on negative—such separation being impossible in the case of sparks between two conductors, as both effects are there necessarily present together.

The phenomena connected with discharge from points group themselves naturally under two heads: Those occurring before or at the beginning of discharge, and those occurring during the passage of electricity from the point. What follows refers to the first of these divisions only.

Section 2.—When an earth-connected sewing-needle is placed with its end facing the centre of an insulated metal plate, and the latter is gradually electrified, there comes a point at which the needle begins to discharge on to the plate. This point, for given conditions, is very definite, and corresponds to a breaking down of some resistance between the needle and the plate. It seemed desirable to discover how much of the dielectric was concerned in this process. For this purpose measurements were made of the strength of the electrostatic field at the surface of the needle-point at the instant that discharge occurred, the distance of the plate from the needle being varied from 0·04 centimetre to 5 centimetres, while the needle was suspended in such a manner (section 8) that the attraction between it and the plate could be determined.

Now the attraction is due of course to the tension in the lines of force which end at the surface of the needle; and since their direction is everywhere normal to the surface, it follows that if the needle be a true cylinder placed symmetrically with regard to the plate, the mechanical pulls of the lines of force upon its sides will balance, and the needle will be urged towards the plate with a force which depends only on the lines ending at its point (its other end being shielded from induction). Moreover, so long as the distance from the point to the plate is greater than a few times the diameter of the point, the distribution of electricity on the latter will be practically independent of that distance; and the strength of the electrostatic field just in front of the point will thus come to be proportional to the square root of the mechanical pull on the point. The needle becomes, in fact, its own electrometer, and measures the difference of potential between its point and the air a short distance from it.

In Table I. the value of the square root of the pull, P, in dynes on the point of a fine * sewing needle at the instant of discharge are given for various distances, d, in centimetres between its point and a metal plate. The constancy of $\sqrt{P}$ speaks for itself.

TABLE I.

NEEDLE A.			NEEDLE B.			
	$\sqrt{P}$.			$\sqrt{P}$.		
d	+ Discharge.	− Discharge.	d.	+ Discharge.	− Discharge.	V.
1·35	...	1·31	1·57	...	1·18	20·6
...	...	1·33	...	...	1·19	20·7
...	...	1·29	...	1·58	...	28·6
...	...	1·31	...	1·60	...	28·0
...	...	1·28	...	...	1·15	20·4
...	...	1·27	...	...	1·17	20·4
...	...	1·26	...	1·60	...	28·1
...	...	1·27	...	1·59	...	28·0
...	1·62	...	1·08	...	1·18	17·4
...	1·65	...	...	...	1·18	18·0
...	1·63	...	...	1·61	...	23·2
...	...	1·26	...	1·62	...	23·5
...	...	1·27	0·76	...	1·17	12·4
...	...	1·26	...	...	1·14	12·6
...	...	1·26	...	1·60	...	17·3
...	1·64	...	...	1·59	...	17·3
...	1·64	...	0·45	1·61	...	12·3
...	1·63	...	...	1·60	...	11·8
...	1·64	...	...	...	1·15	8·47
...	...	1·28	...	...	1·18	8·89
...	...	1·28	0·28	...	1·16	7·10
...	...	1·27	...	...	1·12	6·73
...	...	1·29	...	1·53	...	9·08
3·0	...	1·27	...	1·57	...	9·51
...	...	1·27	0·15	1·59	...	7·18
...	...	1·28	...	1·59	...	7·18
...	1·64	...	...	...	1·13	5·36
...	1·65	...	...	...	1·15	5·41
...	1·65	...	0·10	...	1·13	4·63
5·0	1·64	...	...	...	1·17	4·63
...	1·66	...	...	1·56	...	6·05
...	1·66	...	...	1·59	...	6·27
...	...	1·27	0·04	1·58	...	6·14
...	...	1·28	...	...	...	...
...	...	1·30	...	...	...	...
...	...	1·29	...	...	...	...
...						...
...	1·64	1·28		1·59	1·16	...

It is true that an ordinary sewing-needle is not a perfect cylinder, but tapers gradually to its point, so that part of P must be due to lines of force on its sides; but this must be very small, for the density of charge on the sides is small compared with that at the point, and the force per square centimetre is proportional to the square of the density, and in addition to this the force on the sides has to be resolved into a direction almost at right angles to itself before it can affect P. Indeed, the very constancy of P, when d is varied, may be regarded as evidence that this part of P is negligible. (Other reasons are given in section 3.)

The two needles, A and B, on which the measurements were made were numbered alike by the makers, and the agreement in the values of $\sqrt{P}$ for the two is fairly close. This is the more satisfactory as the readings were taken under somewhat different conditions. The needle A was suspended in the larger of the two instruments described in section 8. It discharged on to a disc of tin 13 centimetres in diameter, with its edge protected by a ring of thick wire. The disc and the inside of the instrument were covered with a thin film of vaseline. The readings on B were taken with the small instrument. The disc in this case was a penny with its surface ground and polished. No vaseline was used. The positive value of $\sqrt{P}$ for the two needles differ by about 3 per cent., whereas the negative values differ by 10 per cent. This is worth pointing out, as it is in accordance with what appears to be a general rule—viz., that the positive discharge is more constant and stable than the negative, and far less independent on the condition of the discharging point.

Section 3.—One may, however, go further than simply showing the constancy of the discharge field at the point. In terms of the attraction of the needle and the radius of curvature of the point, it is possible to calculate its value.

Let da represent an element of area of the point's surface, and θ the angle between the direction of the lines of force at da and the axis of the needle. Then, if the pull on the needle towards the plate be P,

$$P = \frac{1}{8\pi} \int f^2 \cos\theta \, da$$

over the surface of the point, f being the field strength at da.

Take now, the case of a needle with its point ground to a hemisphere, and assume (what will not be strictly true) that the value of

* Sharp's egg-eyed needles, No. 10.

f is uniform all over it (see below). Then the above equation becomes

$$P = \frac{r^2 f^2}{8} \text{ or } f = \frac{\sqrt{8P}}{r}$$

where r is the radius of curvature of the point. The average value of $\sqrt{P}$ for positive discharge from needle B (Table I.) is 1·59. That for negative is 1·16. The value of r for so fine a needle is rather uncertain, as it tapers towards the point. Measured under a microscope it seems to lie between $1·9 \times 10^{-3}$ and $2·3 \times 10^{-3}$ centimetres. Taking the mean of these numbers one obtains the value of the field of force, f, close in front of the point

$$f = \frac{\sqrt{8P}}{r} = 2{,}140 \text{ E.S. units for + discharge.}$$

$$= 1{,}560 \quad \text{,,} \quad \text{,,} \quad - \quad \text{,,}$$

The highest measured value of f for discharge in air is, I believe, that obtained by Dr. Liebig for sparks between plates (*Phil. Mag.*, July, 1887, p. 106)—viz., 400 E.S. units for a spark length of 0·0066 centimetre. This is much less than either of the above numbers, but the length of discharge at the point is probably much less than 0·0066 centimetre. The results may, moreover, be verified by calculation from potential data.

Although the value of f is so large at the surface of the needle point, the lines of force diverge rapidly, and at a very short distance from the point the field becomes inappreciable. In other words, there occurs within this short distance a step of potential (v) which, if the point is hemispherical and small, may be taken as equal to $\frac{Q}{r}$, where Q is twice the charge on the hemisphere (Q, as already assumed, being uniformly distributed over the point).

In the same way $f = \frac{Q}{r^2}$, whence

$$v = \frac{Q}{r} = f\,v = \sqrt{8P},$$

its value being thus independent of the somewhat uncertain quantity r.

For needle B

$$v = 4·5 \text{ E.S. units for + discharge.}$$

$$= 3·3 \quad \text{,,} \quad \text{,,} \quad - \quad \text{,,}$$

In order to verify the above values of f, it will be convenient and sufficient to show that these values of v calculated from P are in agreement with those calculated from potential measurements.

The column headed V, in Table I., gives the difference of potential in E.S. units between the needle and the plate. Now, except for the presence of the needle itself, the field of force in which it was placed would have consisted of parallel lines; for the point of the needle was arranged in this experiment to project three or four millimetres beyond a flat screen of tinfoil through a small hole in it, and the distance from the tinfoil to the disc (a penny) on to which the needle discharged was small compared with the diameter of the disc, so long as the value of d was less, say, than a centimetre. Even with the needle in position, the field would be disturbed for a very small distance only round about the point, on account of the extreme smallness of the latter. Hence V may be regarded as consisting of two parts—one constant (viz., v) and occurring in a small space close to the point; the other proportional to d for small values of d.

The small amount (3 to 6 per cent.) by which the potential step calculated from V exceeds that calculated from P may be accounted for, I think, by the fact that the lines of force from the needle-point do not diverge quite as rapidly as calculation supposed. The parallel lines of the rest of the field keep them together and so increase the real step of potential at the point without altering P in proportion. To test this point I measured P for a needle of about the same size as B, first suspending it in a parallel field, and then with its point at the centre of curvature of a spherical cup. In the first case, $\sqrt{P}$ was about 3 or 4 per cent. less than in the second; showing, as it seems to me in the light of what follows, that in the parallel field, f, at the point was nearer the average value of the field through a small distance from the point-surface than in the radial field of the second case; and to about the same amount that the above discrepancy requires.

This accounts, moreover, for the fact that needle B is the only one which does not agree with the results of Table II. Its constant ($f \times r^{0·8}$) being 15·5 at a pressure of 76 centimetres.

As regards the measurement of potential in the above, the electrometer described in section 8 was used; its constant being determined by comparison with short sparks between brass knobs of 5·3 centimetres diameter.

The following are the readings taken:

Spark length.		V from spark length (E.S. unit).	$\sqrt{}$Electrometer reading.	Constant of electrometer.
Observed.	Corrected for flat plates.			
0·127	0·125	17·8	6·63	2·69
,,	,,	,,	6·63	2·69
0·190	0·186	24·8	9·23	2·68
,,	,,	,,	9·39	2·67

The values of V were taken from Dr. Liebig's paper already referred to.

I think, then, it may be safely concluded that the attraction of a plate on a needle-point is practically due *only* to the lines of force ending at this point, even when the needle is not a perfect cylinder; for a conical point could only have the effect of increasing P and so making the step of potential calculated from it bigger than that from V, whereas the reverse is the case. It is true that the density must be greater at the centre of the point than at the sides of the hemisphere. But this is what P chiefly depends upon, and it is also precisely here that discharge occurs and the value of f is required. Hence the connection established above between P and f seems to be practically true, although the assumption that f is uniform over the point-surface is not.

In what follows, therefore, the values of f have in every case been determined from P and r.

(To be continued.)

TABLE II.

Needle.	r.	f.				$f \times r^{0·8}$.			
		(+) $p = 76$	(−) $p = 40$	(+) $p = 20$	(−) $p = 20$	(+) $p = 76$	(−) $p = 40$	(+) $p = 20$	(−) $p = 20$
C	$0·7 \times 10^{-3}$	? 6,350	? 5,200	? 4,630	? 3,390	[19·0]	[15·6]	[13·8]	[10·1]
D	1·6 ,,	2,850	2,180	1,700	1,200	16·4	12·6	9·8	6·9
E	1·88 ,,	2,450	1,900	1,500	1,050	16·1	12·5	9·8	6·9
F	4·03 ,,	1,400	1,030	810	580	17·0	12·5	9·8	7·0
G	4·84 ,,	1,180	870	643	510	16·6	12·2	9·0	7·1
H	6·52 ,,	935	680	518	405	16·6	12·1	9·2	7·2
I	7·11 ,,	890	630	470	380	17·0	12·1	9·0	7·3
J	7·83 ,,	800	585	450	360	16·5	12·1	9·3	7·4
K	8·71 ,,	780	560	425	320	17·5	12·6	9·5	7·2
L	10·9 ,,	648	450	326	290	17·4	12·1	8·8	7·8
M	31·8 ,,	335	227	152	140	21·2	14·4	9·6	8·8
N	45·7 ,,	308	198	130	138	26·1	16·8	11·0	11·7
O	58·0 ,,	302	194	132	140	30·9	19·9	13·5	18·0

SECONDARY BATTERIES.

MR. G. H. ROBERTSON'S paper, read last week before the Society of Arts, brought out several interesting points relating to the chemistry of secondary batteries, or more particularly the chemistry of the acid, which are worth the careful study of those engaged in this speciality of electrical science. Referring to experiments with electrolytes, he says:—

Although so many different modes of manufacture and preliminary treatment have been resorted to, all the batteries, so far as I am aware, which depend for their action on the couple formed between lead and lead peroxide in dilute sulphuric acid, exhibit the characteristic peculiarities noticed by Planté in his cell, namely:—The high initial E.M.F. of a freshly-charged cell; the fall of E.M.F. on breaking the charging circuit, with corresponding rise on breaking the discharging circuit; the very rapid fall towards the end of discharge which occurs earlier, the more rapid the discharge is, and is not due to the exhaustion of the active material, as after a rest a fresh discharge can be obtained.

As the defects, namely, sulphating and buckling, which have re-

tarded the introduction of reversible lead batteries, are also common to the two types, it appeared possible that they were due to the same causes which produced the variations in E.M.F.; therefore, as the work of Dr. Oliver Lodge* in 1883, and of Miesler† in 1888, had shown that the causes of the variation must be sought either on the lead plate or in the acid next it, and the chemistry of the plates afforded no explanation,‡ I last year, with Dr. Armstrong's advice and assistance, undertook the investigations of the reactions occurring in the acid.

Planté§ had considered that the peculiarities in E.M.F. were due to the formation of peroxides in the acid, and showed that the conditions existing in a cell were favourable to their production, since in voltameters with lead electrodes they were formed in greater quantity than in those with platinum. He also noticed that, immediately on the cessation of the charging current, there was often a small evolution of gas from the peroxide plate; this evolution he ascribed to local action between the peroxide and the subjacent lead.

Commenting on this, in their little book, "The Chemistry of Secondary Batteries," Messrs. Gladstone and Tribe point out that the gas is oxygen, and cannot be due to local action, since the gas was evolved whether the peroxide was removed from the supporting plate or not. The application of heat increased the evolution of gas, and the gas was oxygen. Testing the acid between the plates, they always found traces of something which decolourised permanganate, and might, therefore, be hydrogen dioxide or ozone.

Although a very large amount of work has been done on the electrolysis of sulphuric acid solutions, and the general character of the change in the nature of the products formed as the strength of the solution is varied, is well understood, the only references I was able to find to any examination of the acid in a battery were those just given; and therefore I have ventured to bring the results of my own experiments before this Society, not because I consider them a final solution of the difficult problem of the chemistry of the cell, but because I hope that the study of the changes occurring in the electrolyte may help to elucidate some points which are at present obscure.

And now it may be as well to refer briefly to the work which has been done in sulphuric acid.

In 1878, Berthelot‖ discovered persulphuric acid ($H_2 S_2 O_8$), and brought forward evidence to prove that it is the primary product of the electrolysis of sulphuric acid solutions, and that the hydrogen dioxide—which, from Faraday's time, has been well known to be present in sulphuric acid after electrolysis—is really due to the action of this body on the acid. The products of electrolysis vary with the strength of the acid, 40 per cent. acid (density 1,300) yielding practically no hydrogen dioxide; while below and above that strength it is present in varying proportions. High current density, and an electro-negative condition of the electrodes favours their formation.¶ Persulphuric acid is an unstable body, and begins to decompose as soon as the current which has given rise to it is stopped, and its decomposition is accompanied by the formation of hydrogen dioxide, unless the sulphuric acid is too dilute. Hydrogen dioxide is also unstable when concentrated, but a weak sulphuric acid solution of it is comparatively stable, and the stability increases the less hydrogen dioxide it contains, therefore this body is found in estimable quantities long after the persulphuric acid which gave rise to it has disappeared. Persulphuric acid is at once decomposed by spongy metal, such as platinum black, by heat with evolution of oxygen,** and resembles hydrogen dioxide in these reactions, and in releasing iodine from potassium iodide, but, unlike it, has no action on permanganate of potassium or peroxide of lead. The effect of electrolysing a sulphuric acid solution of hydrogen dioxide is simply to increase the rate of the decomposition occurring spontaneously, if a weak E.M.F. is used;†† but on increasing the E.M.F., though the rate of decomposition is increased, a little persulphuric acid is reformed. Subsequent workers have in the main confirmed Berthelot's conclusions. To the oxidising oxygen in the products of the electrolysis of sulphuric acid, Berthelot gave the name of "active oxygen," and as they pass one into the other, and for most purposes connected with a battery it is not necessary to discriminate between them, I have retained it.

Experiments at the General Post Office.

That the nature of the electrolyte affected the behaviour of the cell, was evident from information received from Mr. Barber-Starkey with respect to the effect of the addition of sodium carbonate, and it seemed possible that the different behaviour of cells containing this substance was due to its catalytic action on hydrogen dioxide, which is known to be exceedingly unstable in the presence of a trace of alkali; and hence a comparative study of the reactions occurring in cells containing ordinary dilute sulphuric acid, and in those which had been treated on Mr. Barber-Starkey's plan seemed likely to elucidate the causes of the sulphating during rest, and the high initial E.M.F.—the two features most affected by this treatment.

Mr. Preece most kindly aided the investigation by allowing experiments to be carried out at the General Post Office, where one half of the secondary cells contain 1 per cent. of sodium sulphate, and the other half ordinary dilute acid, density 1,180. He also put at my disposal the records of the behaviour of the cells, and they proved that there was much less sulphating with sodium sulphate, as shown by the density of the acid never falling to the same extent as in the plain cells. The following readings, taken from short-circuited cells with badly broken plates, illustrate this. In two cells containing ordinary dilute acid, the density of the electrolyte had fallen to 1,100, while, according to the last readings before the short circuit occurred, it had been 1,170 and 1,180 respectively; while in two sodium sulphate cells the density had only fallen to 1,180 from 1,200 under similar circumstances.

This was strong evidence in favour of the hydrogen dioxide formed in the working of the cell being appreciable in quantity, since if sulphating were only due to local action between the support and the paste, there does not appear any reason why the addition of sodium sulphate should affect it.

Whenever the cells were tested they were always found to contain "active oxygen," which was due to the presence of persulphuric acid and peroxide of hydrogen in varying proportions. During charge, persulphuric acid is the main constituent; during discharge the quantity of hydrogen dioxide gradually increases, while in a cell which has been at rest some time, there is very little except hydrogen dioxide to be found.

In addition to the tests made on the cells in the electric light and telegraph batteries, I studied the formation of the "active oxygen" during charge and discharge on some cells which were kindly set apart for my special use. The "active oxygen" forms at once on the passage of the current, decreases slightly, and then increases to a little above its first value. Starting either charge or discharge always causes an initial increase, except in the case of cells which have been long idle, when there is a diminution, due to the decomposition of the excess of hydrogen dioxide in the acid.

To test whether electrolised acid was able to reduce pure peroxide of lead, two equal lots of peroxide were taken by weighing one against the other, and put in two flasks. On to each, 100 cc. of acid, from next the positive plate of a cell at full charge, was poured, and this caused the evolution of oxygen, which continued slowly for some days. At the end of a fortnight the amount of peroxide of lead in each sample was estimated, and it was found to have decreased from 97·4 per cent. to 93·94 and 94·04 per cent. respectively.

This appears to explain the well-known deleterious effect of rest on a cell, for although persulphuric acid itself does not reduce peroxide of lead, it forms hydrogen dioxide on standing, which is capable either of oxidising the lead plate to litharge or of reducing the peroxide plate to the same substance. In each case the litharge is converted into sulphate by the sulphuric acid.

In an ordinary cell in good order the amount of "active oxygen" is small, varying in quantity from about 0·01 grm. to 0·02 grm. per litre; but this means that in a 45-pint cell (the size used at the Post Office) there was always sufficient to convert from 3·25 grms. to 7·5 grms. of peroxide of lead into sulphate, or to undo the work of one to two ampère-hours charge.

This is not a serious matter if the cells are kept working, as the peroxides are being continually broken up with each reversal of the current, but if the cells stand idle the plates get sulphated, and the amount of "active oxygen" formed in the next passage of the current shows a marked increase.

The figures just given do not represent the total amount of "active oxygen," since the acid absorbed by the plates cannot be tested; but, as the acid has more oxidising power, the nearer you get to whichever is the positive plate, except at the commencement of discharge, and the total quantity of "active oxygen" increases rapidly soon after breaking circuit, it seems fair to assume that this increase is due to diffusion from the plates of acid which has more oxidising power than that in the body of the cell.

This increase is followed by a decrease which is rapid at first, and then gradually gets very slow, and practically ceases while there is still a fair proportion of "active oxygen" left in the cell.

In the sodium sulphate cells the amount of the oxidising agent was usually less than in the plain cells; and the amount of hydrogen dioxide was always so, unless the battery had been at rest for some time, when the conditions were occasionally found to be reversed. This, I suppose, is due to the proportion of "active oxygen" in the form of hydrogen dioxide, at the moment of stopping the current, being greater in the plain than in the sodium sulphate cells, while the latter contain more persulphuric acid. In both cells the hydrogen dioxide present at the time of stopping the current will be reduced on the plates, sulphating the surface, and more or less screening them from further action; but, as the sodium sulphate cell contains more persulphuric acid, the subsequent formation of hydrogen dioxide will be greater in it than in the plain cell. As far as I could discover, sodium sulphate has little or no action on the acid unless it is added during electrolysis, or to acid which has just been taken from a cell through which a current is passing.

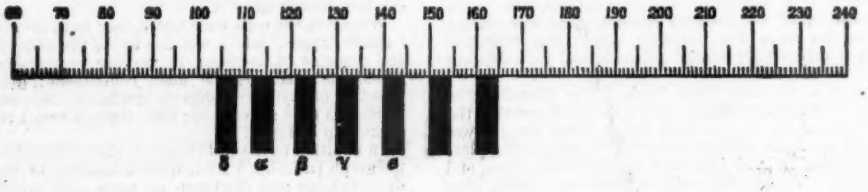
The Pink Colour of the Acid.—It has often been noticed that, during charge, particularly with new cells, a pink colour starts from the peroxide plates, and gradually spreads over towards the lead plates, fading away, however, before reaching them. This pink colour was referred to by Mr. Crompton at a meeting of the Institute of Electrical Engineers on December 13th, 1890, and its origin gave rise to some discussion; so as the acid in many of the cells at the Post Office was pink, I tested it by concentrating it down, neutralising with sodium carbonate, and then igniting on platinum foil, and always got the characteristic green of manganese.

However, lest the manganese should have come from some other source than the pink acid, I compared the absorption spectrum of the acid with that of a solution of potassium permanganate of the same shade of pink, and found they both gave the characteristic bands in the green (see figure). I also found that, using two strips of platinum as electrodes in a solution of manganous sulphate, or any two strips of lead in dilute acid, gave the same colour and the same absorption bands, provided the electrodes were sufficiently far apart

* Cantor lecture.
† "Monatshafte für Chemie," viii., 713.
‡ For references and a summary of the principal work done on the cell, see the *Electrician*, Vol. xxvii., No. 682. p. 165; No. 692, p. 437.
§ "Researches sur l'Electricité."
‖ Berthelot. (*Compt. Rend.*, 90, 269—275.)
¶ Richarz. (*Ann. Phys. Chem.* [2] 31, 912.
** Berthelot. (*Bull. Soc. Chim.* [2], 34, 78—81.)
†† Berthelot. (*Compt. Rend.*, 95, 8—11.)

to prevent reduction by the hydrogen evolved from the negative. This result was important, for it is well known that the pink colour disappears from the acid in a short time if it is taken from the cell, and as persulphuric acid has no action on permanganate, but hydrogen dioxide discolourises it, this disappearance of the colour shows that the latter is formed.

The Effects of Hydrogen Dioxide on the E.M.F. of a Cell.—The presence of hydrogen dioxide having been thus proved, both directly and indirectly, its effect on the E.M.F. of the cell was tested. This was done by using strips of lead packed tight into small porous pots, with peroxide of lead to represent the peroxide plates, and using



plain strips as the lead plates. A solution of pure sulphuric acid, density 1,180, was used as the electrolyte. The E.M.F. of the couple was taken by the deflection method, and then a drop or two of hydrogen dioxide was added to the acid, which produced a great diminution, or even reversal, of the E.M.F.

The effect of introducing hydrogen dioxide into the body of the peroxide paste was also tried with a view of reproducing, if possible, the conditions of a cell which is started discharging directly the charge is completed, and in which the "active oxygen" would be accumulated at the positive plate, leaving the lead plate free, and I found that there was a slight increase in E.M.F.

Thus the variations in E.M.F. appear to depend on which plate hydrogen dioxide is formed at. When present at the peroxide plate it causes a rise, but when diffused through the acid and present at the lead plate it causes a lowering of the E.M.F.; and the rise in E.M.F., sometimes noticed on starting the discharge of a cell which has been at rest (mentioned in Prof. Ayrton's paper, J.I.E.E., 1890, p. 572), is probably due to the electrolysis and decomposition of hydrogen dioxide, for, in a cell which has been long idle, practically the whole of the "active oxygen" is due to this body.

CONCLUSIONS.

From the same faults appearing in batteries of such different construction, and judging also from the results of the experiments recorded in this paper, it would appear that the troubles occurring in batteries are due rather to causes arising in the working than in the manufacture. What is required is some substance which can be added to the acid to check the formation of the oxidised bodies in it, which cause sulphating, without at the same time injuring the plates in other ways.

Nearly all the "forming" baths which have been introduced are baths in which hydrogen dioxide would be broken up as soon as formed, and, perhaps, in some modification of them the electrolyte of the future will be found; though, since the products of the electrolysis of sulphuric acid vary with the strength of the acid and the current density, no hard and fast rule can be laid down for the treatment of cells.

In cells containing acid below density 1,200, in which the proportion of "active oxygen" existing as hydrogen dioxide is high, the addition of one per cent. of sodium sulphate, or similar substance, is likely to prove beneficial, particularly if the work of the cells is intermittent. As the strength of the acid is increased, however, and the conditions are more favourable to the stability of persulphuric acid, less hydrogen dioxide will be produced, and there is more chance of the alkali released from the sodium sulphate during electrolysis damaging the plates.

Also, Dr. Marshall has succeeded in preparing pure persulphuric acid, and has shown this year that it forms salts with the alkalies which are very stable; and what the effect on a cell of the formation of sodium persulphate in it would be, is quite unknown. Although the formation of peroxides in the acid does not apparently account for the great gasing and sudden loss of charge sometimes observed, still we have seen that makers are reverting to Planté's process of manufacture, or modifications of it, and we may find that in this case also he was right, and that it is to the electrolyte we must look if we wish to find the means of materially improving the lead reversible battery.

NEW PATENTS—1891.

20,312 "Improvement in the form of electrical battery cells, boxes, or other vessels." J. M. MOFFAT. Dated November 23rd.

20,314. "Electrical thermometer." J. GRATTON. Dated November 23rd.

20,322. "An improved means of reproducing the indications of electrical measuring instruments at a distance." H. W. MILLER. Dated November 23rd.

20,328. "Improvements in producing alternating currents differing in phase." R. KENNEDY. Dated November 23rd.

20,356. "Improvements connected with electric arc lamps." W. STORR. Dated November 23rd.

20,367. "Improvements in couplings for electric wires." A. SHIELS. Dated November 24th.

20,389. "Magnetic microphone." E. T. WHITELOW. Dated November 24th.

20,407. "Improvements in the manufacture of a hard insulating material." R. PAPE. Dated November 24th. (*Complete.*)

20,413. "Improved electrolytic apparatus, more particularly applicable for manufacturing caustic soda and other products from salt, but also applicable to other purposes." G. BAMBERG. Dated November 24th.

20,416. "Improvements in apparatus for separating magnetic ore from sand." F. J. BELL and W. B. BASSET. Dated November 24th.

20,485. "Improvements in automatic safety devices for electric circuits." F. BRYAN. Dated November 25th. (*Complete.*)

20,492. "Regulating electric currents." L. B. MILLER and M. W. WOODS. Dated November 25th.

20,496. "Electrical switch." A. CHAMPION and J. MOSS. Dated November 25th.

20,506. "Improvements in microphone transmitters." Sir C. S. FORBES. Dated November 25th.

20,508. "Improvements in and relating to dynamo-electric machines." T. H. WILLIAMS. Dated November 25th.

20,524. "An improved combined fitting for gas and electric lights." W. W. HORN. (Communicated by O. Strom, United States.) Dated November 25th.

20,530. "Improvements in and relating to ship telegraphs." A. B. W. H. CORDS. Dated November 25th.

20,542. "Improved incandescent lamp holder and form or shape of incandescent lamps." T. J. RICKARD. Dated November 26th.

20,545. "An improved system of telephonic exchange signalling." A. R. BENNETT and R. MCLEAN. Dated November 26th.

20,595. "Improvements in arc lamps." F. R. BOARDMAN. Dated November 26th.

20,604. "Improvements in electric-motors or generators." H. H. LAKE. (Communicated by W. Stanley, jun., and J. F. Kelly, United States.) Dated November 26th. (*Complete.*)

20,623. "Improvements in telephone transmitters." W. MAXWELL. Dated November 27th.

20,629. "Improvements in holders for incandescent electric lamps." C. M. DORMAN and R. A. SMITH. Dated November 27th. (*Complete.*)

20,642. "Improvements in apparatus for automatically controlling the direction of electric currents singly or in groups as for illuminating advertisements and the like." E. BURGESS. Dated November 27th.

20,678. "Improvements in electric burglar alarms." F. POHL, jun. Dated November 27th. (*Complete.*)

20,689. "Improved cementitious and electric insulating compounds." M. MACKAY. Dated November 27th.

20,699. "A new or improved electric indicator." H. W. THATCHER and A. DEVEREUX. Dated November 27th.

20,718. "Magnetic electric boot and shoe (iron and steel) grindery." P. PINCKNEY. Dated November 28th.

20,748. "Treatment of and production of valuable products from sludge obtained by electrical treatment of sewage." F. SCUDDER. Dated November 28th.

20,799. "Improvements relating to electric call systems and apparatus for use therein." W. H. BLAKENEY. Dated November 28th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

11,601. "A process for obtaining metals in molten condition from their fused oxides by electrical action." A. H. COWLES. (Partly communicated from abroad by F. W. Matthiessen, of America.) Dated July 24th. 4d. Claim:—The process for obtaining metals in molten condition from their fused oxides by electrical action, the said oxides being fused along with fluxes selected according to the conditions herein set forth.

11,962. "Improvements in electric bells." E. W. LANCASTER. Dated July 31st. 8d. Consists chiefly in the use of porcelain instead of wood, and in the particular form and shape of the covering arrangements, and simplicity of parts and easy production. 4 claims.

12,439. "Improvements in and relating to electric lamps or lighting apparatus." A. L. SHEPARD. Dated August 8th. 11d. Relates chiefly to motor lamps, in which the operation of the carbons is effected by means of an electric motor, the working of the motor being controlled by a relay which operates two or more contact points, some of which are fixed and some movable, as, for instance, one or more movable tongues working in combination with fixed points of contact. 11 claims.

12,874. "Improved electric switch." C. R. BONNE. (Communicated from abroad by the Actien Gesellschaft Mix and Genest, of Berlin.) Dated August 16th. 8d. Upon turning the handle a disc with projecting piece thereon is revolved, and with it a contact lever, which latter being mounted upon an axis or pivot a certain distance away from its centre has an eccentric movement imparted to it in relation to the axis of an adjacent disc. The motion of the handle being continued, the projecting piece on the first-mentioned disc strikes against the edge of the larger disc or segment above the contact lever, and, at the same time, the pin or projection on the upper surface of the latter, being between the spiral springs, compresses the spring on one side, by which its forward motion is obstructed. Meantime the contact lever has free movement, the contact piece connected to its extremity on the under side is forced between the two flat springs joined to the conducting screw on the base of the switch, and contact is made with the conducting screw in the frame thereof. 3 claims.

12,914. "Improvements in switches for controlling and regulating double or compound electric motors, especially applicable to traction or marine propulsion." A. J. JARMAN. Dated August 18th. 8d. The objects sought to be attained are:—First, to prevent undue sparking, or the formation of an arc when the contact is broken by moving the switch; second, to reduce the effect of self-induction caused by suddenly cutting a helix of many turns out of the electrical circuit; third, to afford absolute security in working, independently of the care and skill of the operator; fourth, to generally improve the construction of such switches by rendering them easier of access, increasing the insulation, and improving the durability of the apparatus generally. 5 claims.

13,123. "Improvements in electricity meters for alternating or interrupted currents." G. HOOKHAM. Dated August 21st. 8d. Relates to improvements in that class of electro-motors in which motion is communicated to a metallic disc, or other solid of revolution, commonly called an armature, by the reaction of currents induced in the disc, the circuits of such currents being completed within the disc, and in the combination of such a motor with an electric brake similar to that described in the complete specifications of letters patent 4,225, 1887, and 17,502, 1887, respectively. 2 claims.

15,191. "Improved process or method of renewing flexible carbon filaments in glow or incandescent electric lamps." C. PAUTHONIER and L'INCANDESCENCE ELECTRIQUE SOCIETE. Dated September 25th. 4d. A line is traced by means of a diamond or a file on the globe, preferably at that part where the button or knob is situated, and by applying a piece of hot glass or an iron heated to redness to the mark, the glass will crack at the mark for the air to enter slowly. The piece is then removed, the opening being of sufficient size to allow of the easy insertion of a new filament by pliers, which holds and maintains the ends of a filament at a distance apart, about equal to that between the platinum electrodes. 2 claims.

15,673. "Improvements in telephonic switching and signalling apparatus." H. T. O. FRASER. Dated October 3rd. 1s. 1d. According to the invention, the piece which makes contact with the several springs in connection with the different lines is carried by a disc, having in its face or side, or in its edge, a number of holes or recesses, at intervals apart, corresponding to the position of the contact springs and the numbered indicator outside the switchboard. When the said disc is rotated, a spring pin is caused to engage with the said recesses, and when the movement of rotation is discontinued the disc will be retained in the position to which it has been brought by the pin, engaging in that one of the recesses in the disc which is opposite to the said pin. 9 claims.

15,819, "Improvements in electric dynamos, electric motors, transformers of electric currents, and induction coils." J. JOHNSTONE. Dated October 7th. 8d. Consists in inserting within its course in each machine metallic vessels containing air or any of the gases at the pressure of the atmosphere, but sealed up so that the external air has no communication with the secluded air or gases within the said metallic vessels. Also, if required by an operator, the secluded air or gases may be rarefied within these metallic vessels, either by the application of heat or by means of an air-pump, suitable apertures being made a part of these vessels for this purpose. 2 claims.

15,828. "Improvements in dynamo machines." W. F. KING. Dated October 7th. 6d. According to the invention, the magnets and their excitation are so arranged that the friction is reduced. For instance, in a four-pole machine with vertical magnets, the inventor makes the field stronger at the top than at the bottom, so that the magnetic pull counteracts the weight of the armature. 3 claims

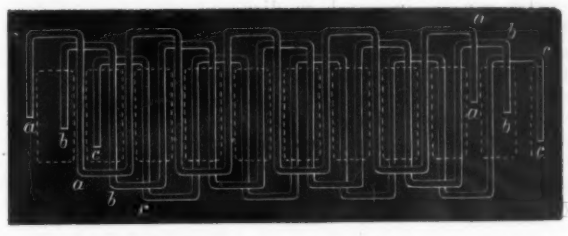
15,921. "Improvements in and relating to incandescent electric lamps." R. DICK and J. D. MACLEAN. Dated October 8th. 8d. Consists in the arrangement and use of a conductor or collector which has more affinity for the volatilised carbon than the glass or surface of the globe, preferably soft iron or other suitable metal, or carbon placed sufficiently near the filament or light conductor, that it will receive and collect on its surface all or nearly all the volatilised carbon particles liberated or given off from the incandescent filament. 3 claims.

CORRESPONDENCE.

Triphased Alternating Currents.

In your issue for October 23rd, there is given, on page 475, a symbolical illustration of the "Winding of Brown's Triphased Alternator at Lauffen." But a dynamo wound as indicated in that figure could not generate three alternate currents differing by 120° in phase.

The correct method of winding the armature, the one in fact actually adopted in the Lauffen dynamo, is symbolically represented in the accompanying figure, which indicates a portion of the circumference of the armature laid out flat; the pole pieces of the rotatory field magnet are indicated by the dotted rectangles, and a portion of the three windings on the cylindrical surface of the stationary armature by *a a a a*, *b b b b*, *c c c c*. To avoid confusion in the illustration, the armature bars, which are parallel to the length of the pole pieces, have been made longer in proportion than they really are.



The distance between the up wire and the next down wire of any one of the three circuits is equal to the distance between the centres of two pole pieces, that is equal to $\frac{1}{3}$rd of the circumference of the armature; while the distance between the up wire of any one circuit, *a a a a*, and the next up wire of the circuit behind it, *b b b b*, must be $\frac{2}{3}$rds of the distance between the centres of two poles, that is, must be equal to $\frac{1}{4\frac{1}{2}}$th of the circumference of the armature.

W. E. Ayrton.

[For reply see "Notes."—EDS. ELEC. REV.]

Granulated Iron Cores.

Re your article on "Granulated Iron Cores," I beg to state that I made some experiments with iron filings in brass and sheet iron tubes. I think Mr. Leslie B. Miller, of Miller and Woods, to whom I communicated my ideas about six years ago, will remember the fact. I also tried the use of iron filings in the construction of electric meters, but in both cases without satisfactory results. In fact, I never expected any practical result from the outset, but merely made the trial from an experimental point of view.

G. A. Nussbaum.

From a reference in your last issue I notice, through the medium of an American journal, that I have been credited—or discredited I should say—with proposing the use of cores for dynamos and motors constructed of a mass of iron filings. I presume this mistake has originated from the fact of my having lately taken out two patents for the construction of such cores for various forms of measuring instruments. In certain forms of ammeters and voltmeters I have applied cores of iron filings mixed with a binding substance and found such had many advantages, one being their adaptability to direct as well as alternating currents. Also in case of electric meters constructed on the motor principle, I have used them with advantage. Also in some instruments, where solenoids and small electro-magnets are used, I have substituted these cores in the place of ordinary solid ones. The idea of applying such to motors and dynamos generally is one for which I must confess I am not responsible. In the case of small instruments as described the principle may

be applied with advantage, and it is to such only that the patents refer.

S. C. C. Currie.

December 5th, 1891.

The Standard Volt and Ampèremeter used at Leven Shipyard, Dumbarton.

In Messrs. Wm. Denny and Brothers' electrical department, we measure accurately the steam consumption and electrical horse-power of all generating plant for ship use. We don't find it necessary, however, to use so complicated an arrangement as that described in the paper read before the Institute of Electrical Engineers. That paper states that the accuracy of the ampèremeter and voltmeter must be within $\frac{1}{8}$th per cent. Our instruments are two Thomson standard electric balances, accurate to within $\frac{1}{10}$th per cent. We use either a wire resistance frame, with a suitable plug arrangement, or a lamp frame arranged so that the number of lamps in circuit can be increased or decreased as required. Our reason for using the latter is, that it appeals more to non-electrical people, who don't know what volts and ampères mean. But to return to the instruments. They are connected in the usual way, that is the ampère balance in series with the circuit, and the voltmeter across the terminals of the dynamo. The joining up can be done in a few minutes; there is no bother with lamps and scales, standard ohms, standard cells, shunts, &c., and, as I said before, the instruments are always accurate within $\frac{1}{10}$th per cent.

Malcolm Sutherland.

December 3rd, 1891.

Steam Dynamo Efficiencies.

With reference to your editorial note on the above matter, I have pleasure in informing you that the two last sets of steam dynamos received from Messrs. Willans's works for the use of a company to which I am the consulting engineer, ranged between 86 and 87 per cent., the lowest being 86·1 and the highest 86·8. The certified consumption of water per E.H.P. per hour, tested over a six hours' run, was 24 lbs. These figures are taken from Messrs. Willans and Robinson's printed certificate, the trials having taken place in the presence of and to the satisfaction of my engineers. The efficiency of the three last steam dynamos supplied by Messrs. Willans and Robinson to the Birmingham Electric Lighting Company was 85·8 at full load, and 78·1 at half load. I enclose herewith a copy of the efficiency curve furnished to me by Messrs. Willans. There is not a word in my last week's letter to you stating that we got such efficiencies as these except during test runs, but I have actually made a long run in the Knightsbridge station with a set which gave on trial 83 per cent. efficiency and succeeded in producing the E.H.P. for a consumption of 2·7 lbs. of Welsh coal. In this case the water was not measured, but as it is pretty well known that the evaporation of the Babcock and Wilcox boilers used does not exceed at the outside 9 lbs. of water per 1 lb. of coal, it is evident that in this case the water used per E.H.P. per hour was very little in excess of the 24 lbs. It is this last figure that is the important one, and in order that it might be placed beyond doubt, it was a necessity that Messrs. Willans's methods of measuring the E.H.P. should also be placed beyond doubt. You will nowhere find in my letter any claim that such efficiencies as these are obtained in practice in central stations. We should obtain them if we could always run at full load, but, as I pointed out in my Paper on the Cost of Electrical Energy, two causes which increase the consumption of coal and water beyond the 3½ lbs. per unit which corresponds with the 2·7 lbs. above mentioned, are entirely due to intermittent working, and, all other things being equal, those steam dynamos which, like the Birmingham sets, show not only a high efficiency at full load but also at half load, are sure to give good results in regular working.

R. E. Crompton.

December 7th, 1891.

Engine and Dynamo Efficiencies.

Referring to Mr. Crompton's statement in the ELECTRICAL REVIEW last week, that plant consisting of dynamos coupled to Willans's engines have given combined efficiencies of from 83 to 87 per cent., you say that "even the Thames Ditton firm admit a loss of 10 per cent. for friction in their engines, and suggest that it is not unwise to increase it to 15."

The "admission" referred to is probably a paragraph in our price list, which, under the circumstances, we trust you will allow to be quoted. It is: "At full load, and after a fair amount of running, the actual or brake H.P. of the larger engines is quite 90 per cent. of the I.H.P., and frequently as much as 92 or 93 per cent. With smaller engines, more lightly loaded, the proportion may fall to 85 per cent., and with extremely low pressures (where the total work done in the cylinders is small in comparison with the size of the engine), the proportionate loss due to engine friction may be even greater. Under ordinary circumstances the brake H.P. may be assumed at from 85 to 90 per cent. of the indicated power." This is simply a warning in general terms to prevent buyers from cutting their power too fine, under circumstances which may be less favourable than they suppose.

With 95 per cent. efficiency in the dynamo (which we believe is often reached) and 91 per cent. in the engine, the combined efficiency is 86·45, or 87·4 if the engine has 92 per cent. efficiency.

We have no record so high as the latter figures, for trials at Thames Ditton are naturally made with engines which are stiff on account of newness and want of running; but we see no reason why they should not be reached in a central station after a few weeks or months of work. At least we fail to see, in the paragraph quoted, any reason to the contrary, or anything inconsistent with Mr. Crompton's statement.

It is of course open to anyone to hold that we furnish information which is not true, and that we avail ourselves of the "vagaries of indicators" to produce misleading results; but as we have taken much pains to put ourselves in a position to cope with the vagaries of indicators, and other more serious hindrances to accurate measurement, we are glad to know that a much more favourable view is generally held, and that our figures are accepted without hesitation by the many practical engineers and men of science who have conducted their own trials here, or have assisted in ours.

Annexed are the figures of some recent trials:—

Date.	Engine.		Dynamo.		Steam pressure lbs.	Revolutions.	Ampères.	Volts.	Horse-power.		Efficiency.
	Size.	No.	Maker.	No.					Electrical.	Indicated.	
1891.											
Oct. 30th ...	G.G.—S.	1,281	Siemens	2,719	145	414	574	105·6	81·22	94·6	85·86 per cent.
Nov. 10th ...	G.G.—S.	1,282	„	2,720	145	451	573	105·8	81·24	94·8	85·7 „
May 15th ...	II.	967	Crompton	2,103	147	348	504·3	239·8	162·1	188·5	86·0 „
Feb. 6th ...	III.	968	Siemens	2,575	121	319	1,221	150	245·5	281·2	87·24 „

These trials were all non-condensing. The last, that of the III. engine, was not made with our standard instruments but with instruments supplied by Messrs. Siemens. Our many and careful tests of their instruments have only shown their high accuracy, but as the instruments used at this trial were not those for which we ourselves take responsibility, the results are not put forward by us as having quite the same authority as the others.

Willans & Robinson, Limited,

C. S. ESSEX, *Secretary.*

December 9th, 1891.